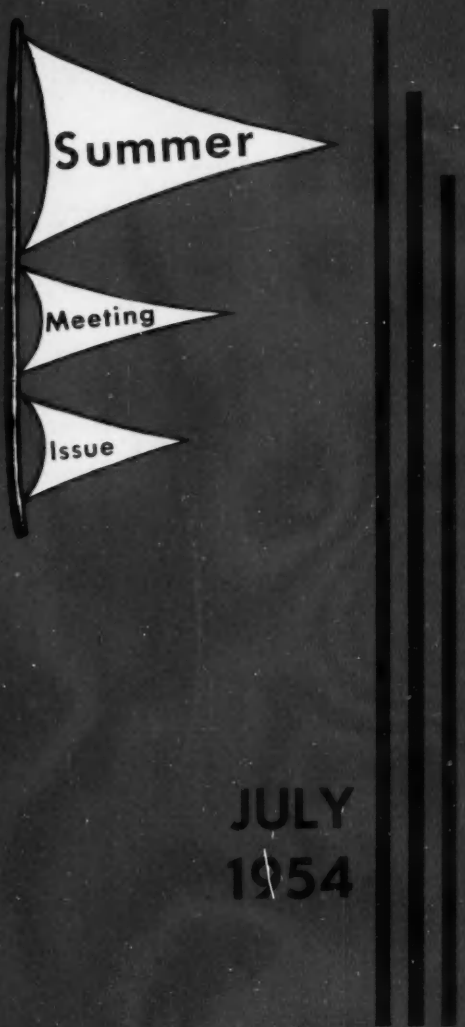
SAE JOURNAL



JULY
1954

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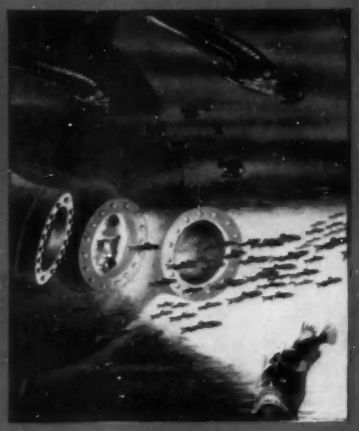
PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS

DID YOU KNOW

that in a car's engine...

TEMPERATURE *during combustion reaches as much as 3 times the heat of molten lava?*



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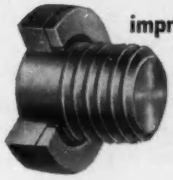
Precision Dyna-seals solve plug sealing problems on NATCO HOLEPAK

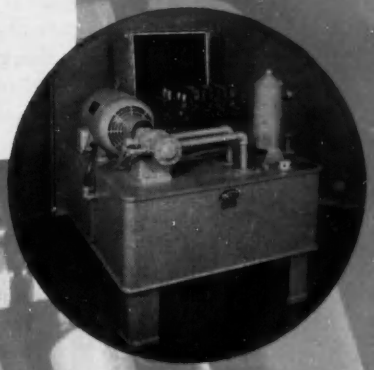
old plug design—

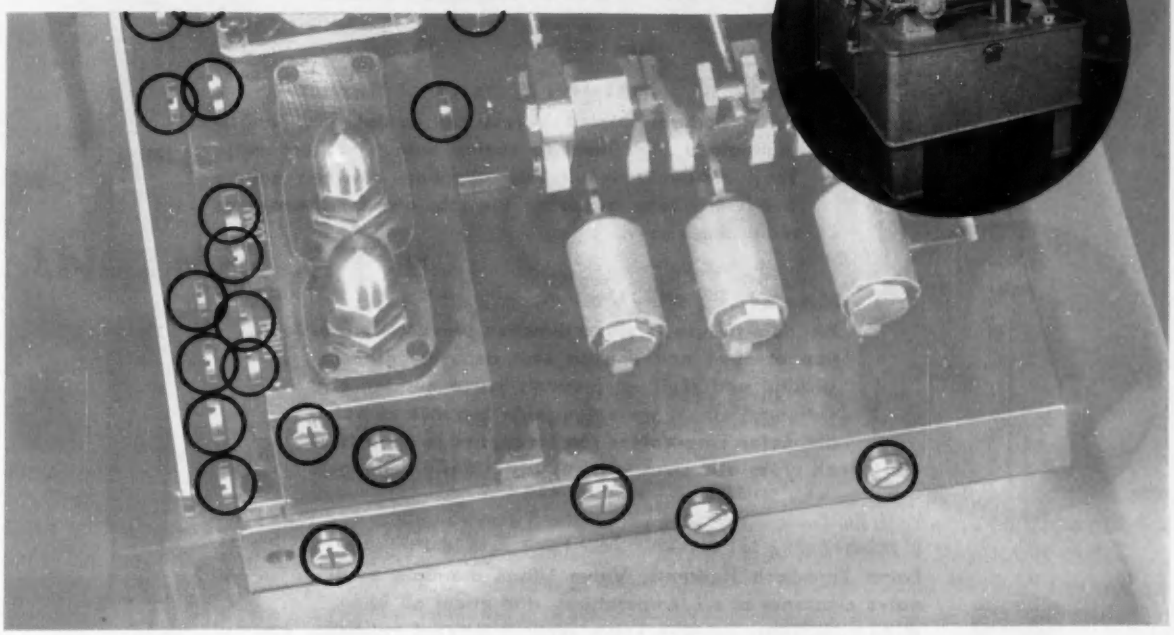
used an "O" Ring in a groove. Plugs were expensive, required close tolerances, permitted leakage.



improved plug design—

uses Precision Dyna-seals. Plugs are inexpensive, tolerances not critical. Assembly is much simpler, leakage eliminated.





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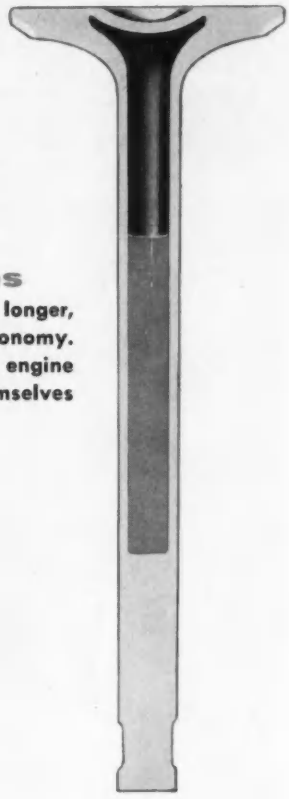

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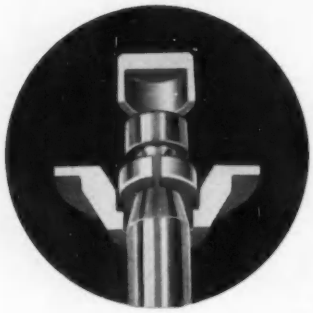
Eaton Sodium Cooled Valves run cooler, last longer, maintain a high level of engine output and economy. They ordinarily require no attention between engine overhauls; keep trucks on the job; pay for themselves many times over.



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Freedom to turn in either direction prevents formation of stem and uneven seat deposits; prevents sticking and scuffing; prevents valve burning and guttering; effects an appreciable increase in valve life. Eaton Free-Valves can be applied to engines of all types and sizes without costly design changes.

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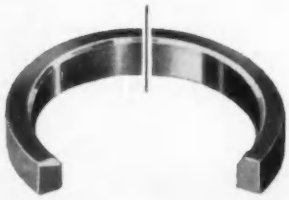

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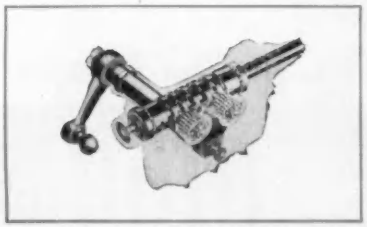

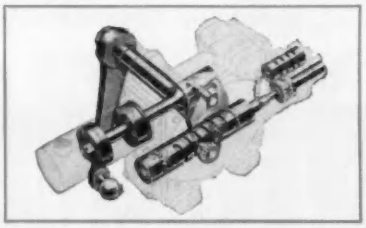

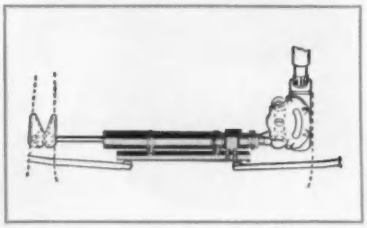

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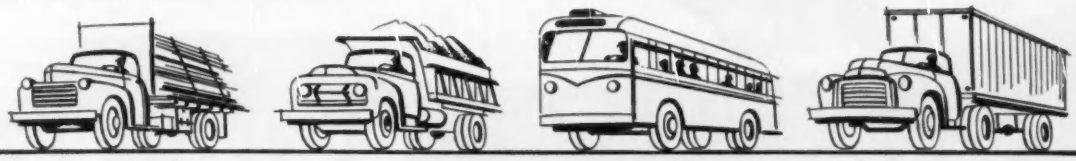

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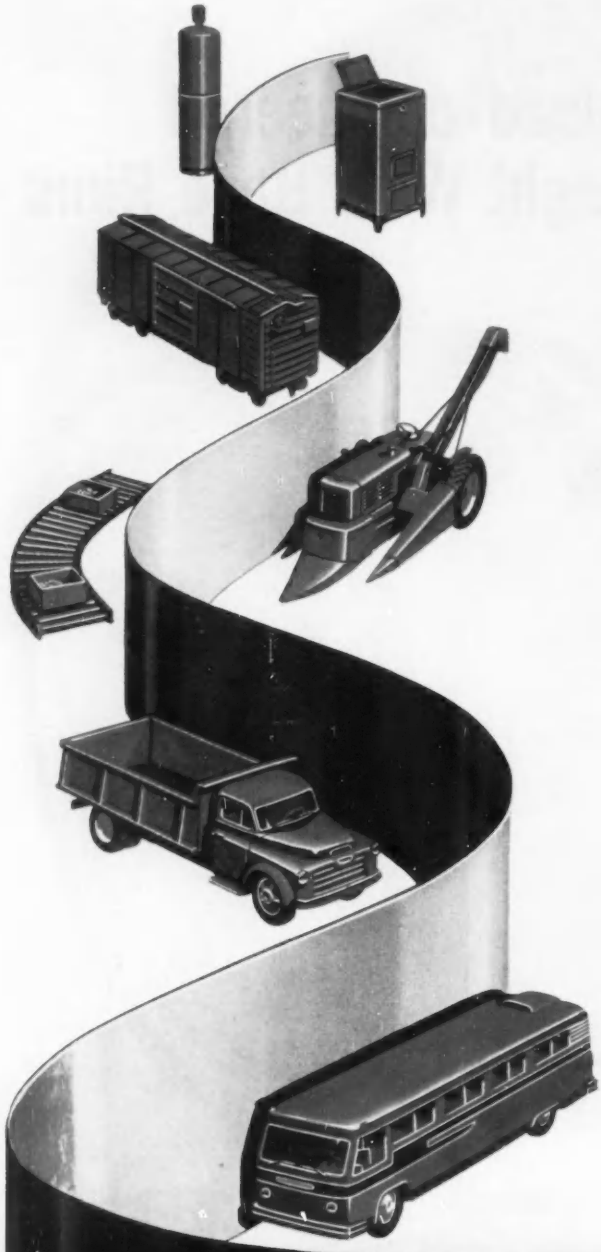

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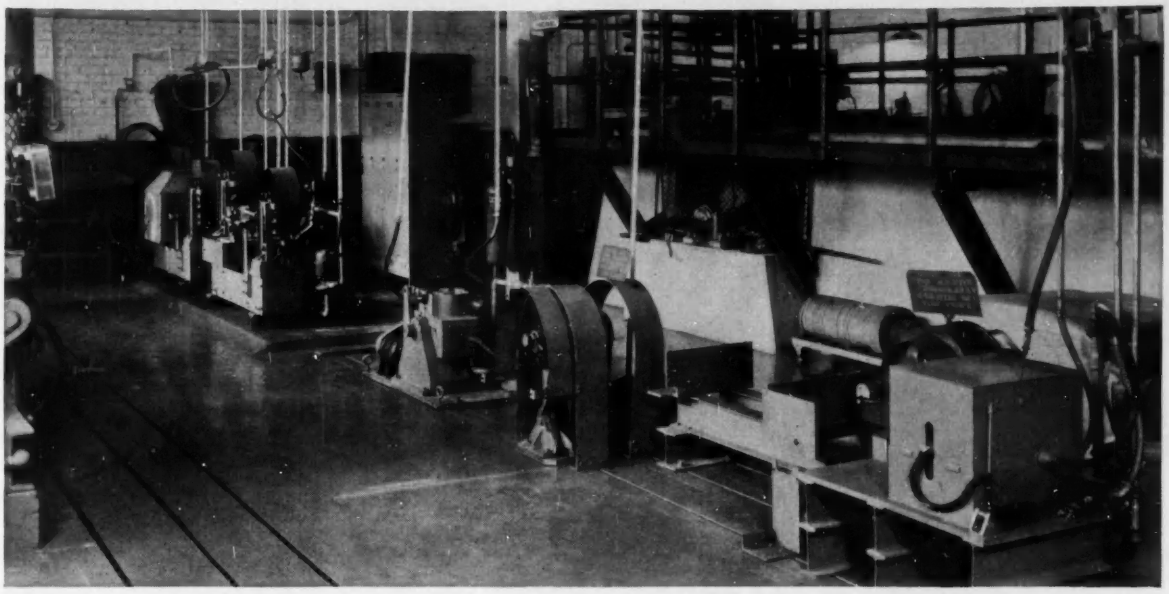

THOMPSON MAINTAINS THIS "TORTURE CHAMBER" in their Detroit laboratories to "performance-test" steering-linkage units under the most extreme conditions . . . tests that reveal the slightest imperfection.

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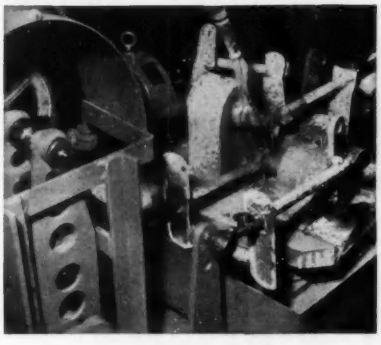

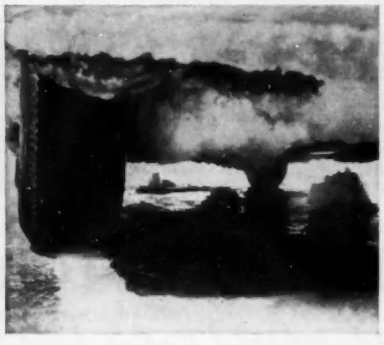

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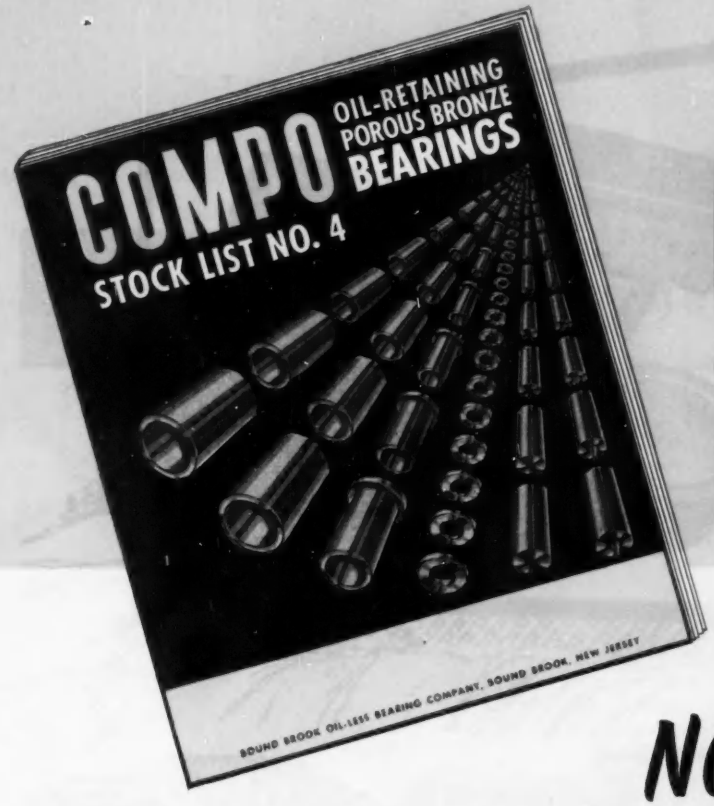

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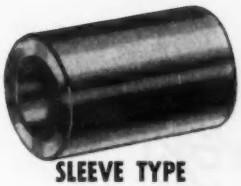
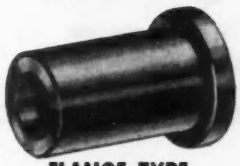


SLEEVE TYPE



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If you play a part in the design, production or maintenance of equipment using sintered bronze bearings, or if the job of purchasing bearings falls within your domain, you'll find a wealth of useful information within the 20 pages of the new Compo Oil-Retaining Porous Bronze Bearing Stock List No. 4. Bound Brook has compiled an easy-to-read list of the most popular stock sizes of bearings which are available for immediate shipment. In addition the Compo Stock List Brings you up-to-the-minute data on bearing application, installation, lubrication and machining. And here's another thought! When requesting your copy of the Compo Stock List why not have us send one to your supplier of bearing-using components or equipment? It may enable him to make savings beneficial to you both.

Write for a list of location of local warehouse stocks. 4

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For the Sake of Argument

Leaders and Decisions . . .

By Norman G. Shidle

A leader becomes a leader by no single process more than by his decision-making. The way he prepares for his decisions, how he expresses them, the degree to which they are readily accepted . . . all these bear on the making or the breaking of a leadership.

We all have to make decisions sometimes. But the accepted leader is on a tougher spot if he wants to stay a leader. He has to analyze before he decides. He has to bring knowledge to focus in his decision.

Besides, as Occidental College President Arthur J. Coons points out:

"The leader cannot ride fences and remain a leader.

"He must learn to make up his own mind—but to have a reason for the faith that is in him that he is on the right side.

"He must be able to interpret and explain his decisions. . . . But, at the same time, his mind must stay open for new information or facts related to the decision in question."

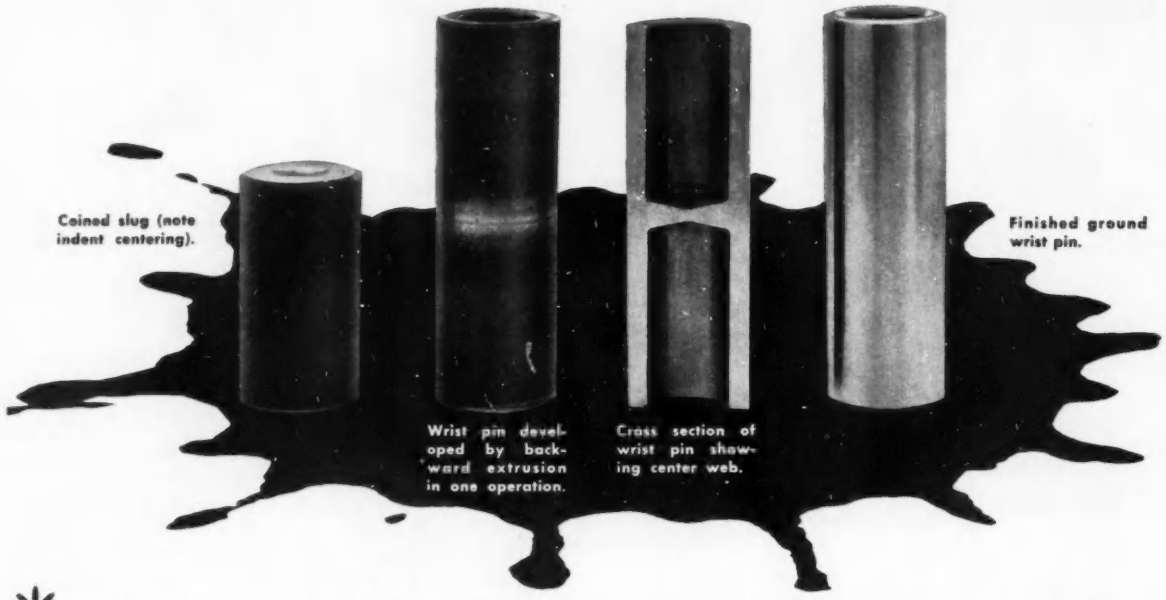
In a word, he rarely makes final decisions. On the best data immediately available, he *does* decide, so projects can get under way. But he sticks around and follows the team in action. He participates in the game as did Knute Rockne with his Four Horsemen. He doesn't decide on a record to be played and then step out until it is finished. He leads a live orchestra from prelude to finale.

Decision-making becomes a steady part of the leader's everyday life; a mechanism through which he contributes to the welfare of his fellows.

Most experienced leaders change their decisions often; their principles rarely. They seem to adhere consistently to explainable principles; modify decisions when new facts or ideas change the relation of the old decision to the principles. They never say "Yes" today and "No" tomorrow for reasons that aren't bought by those the change affects.

One executive of high standing agrees that leadership must be decision-making but adds: "My best decisions, I believe, are those with which the people affected sincerely agree. I've come to be suspicious of the merit of those which are obeyed but not bought, accepted but not believed in."

*Bonderite


Coined slug (note indent centering).
Wrist pin developed by backward extrusion in one operation.
Cross section of wrist pin showing center web.
Finished ground wrist pin.

*as a separating layer and lubricant carrier is the key to the success of COLD FORMING

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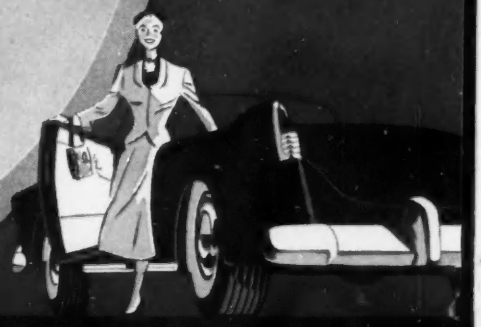

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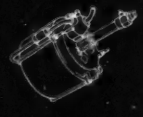

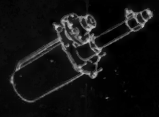

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Summer Meeting Report

SAE's third successive Atlantic City Summer Meeting, June 6-11, attracted more than 1300 members and guests. The tangy salt water air added zest to debates on provocative automotive topics as well as zeal to the off-hour diversions. Technical sessions and round tables took the play from many boardwalk attractions judging by the good audiences and high interest, vocally demonstrated in the session rooms. The shore menu of technical treats covered the waterfront of current automotive interests . . . gas turbines for vehicles and diesels for airplanes . . . automobile air conditioning and car heating . . . better truck brakes and faster car road races . . . the hottest thing in motor oils and operation of refrigerated vehicles.

Continued on page 65

Turbine Invades Piston's

GMC's turbine-powered bus and car give promising answers to long-standing questions. Engineers have leads on how to curb gas turbine's fuel appetite.

Turbocruiser Coach Is First . . .

. . . Gas Turbine-Powered Bus

This GMC transit bus was a natural as a test vehicle for the Whirlfire GT-300 gas turbine engine.

- The engine could be installed in the existing engine compartment with ample space for special test instrumentation.
- The vehicle could be ballasted to represent a wide variety of service conditions with little difficulty.
- The seating capacity could be used to advantage in demonstrating the new type of powerplant.
- Plenty of space was available to accommodate the special test equipment and observers.

Externally the Turbocruiser differs from the diesel-powered coach only in the provision for an exhaust duct discharging through the rear roof crown panel.

Ground Vehicle Domain

W. A. Turunen, Research Laboratories Division, GMC

Excerpts from paper "Pinwheels or Pistons," presented at SAE Summer Meeting, Atlantic City, June 9, 1954.

"IN view of the developments which seem sure to materialize, the future of the gas turbine must be contemplated with an open mind and with a degree of optimism." This statement—which we made five years ago in an SAE paper* on automotive gas turbine possibilities—still holds true.

Experience in operating two gas turbines we have built since that time (one for a bus and one for a car) support this five-year old statement.

We feel future developments still hold the key to general acceptance of the gas turbine for road equipment. These developments must encompass improved fuel economy, reduced acceleration time, and a suitable dynamic braking system.

Both Whirlfire gas turbine installations have demonstrated that smooth, reliable operation with very desirable power and torque characteristics can be attained. These, coupled with the very favorable weight-to-power ratio, already have been applied to advantage in the two specialized installations.

From Paper to Metal

The initial paper pointed out the possible advantages as well as the disadvantages of automotive gas turbines. However, a paper study can only list these factors. So it was decided that a small gas turbine be built and tested to evaluate these advantages and disadvantages in a particular installation to learn more about the effect of each.

The design of the first Whirlfire engine, the GT-300, was based on the following criteria:

1. The initial study indicated that the area in which the gas turbine might best make its initial entry into the transportation field would be in the heavy-duty or commercial installations. It was therefore decided to build a unit which would develop 300 hp at the shaft.
2. It was recognized that problems, some anticipated and some unforeseen, were bound to arise in the development of an engine such as the GT-300. Consequently it was decided to emphasize mechanical simplicity and reliability in the original design rather than strive for the ultimate in fuel economy.

Selecting Design Parameters

In the interest of simplicity, it was decided that a centrifugal compressor with a design point pressure ratio of 3.5 would be used. To take advantage of its excellent torque characteristics, the dual turbine arrangement with separate gasifier and power turbines was selected. It was decided that both turbines should be single-stage axial flow units.

The inlet temperature to the gasifier turbine was set at 1500 F for reasonable bucket life. It was felt that a two-bearing gasifier shaft would be extremely desirable; and this consideration, coupled with shaft critical speeds and adequate bearing life, contributed to the final choice of 25,000 rpm for the design point gasifier speed. This selection of speed then established the diameters of the compressor rotor and the gasifier turbine. High turbine speed with minimum size and weight was balanced against low rotative speed with decreased bucket stresses and lower gear ratios in the final selection of 12,000 rpm as the design point for the power turbine.

Please Turn Page

* See SAE Quarterly Transactions, Vol. 4, No. 1, January, 1950, pp. 102–115: "Gas Turbines in Automobiles," by W. A. Turunen. Paper was presented at SAE Summer Meeting, French Lick, Ind., June 8, 1949.

1. Here Is What the Bus Engine Is Like

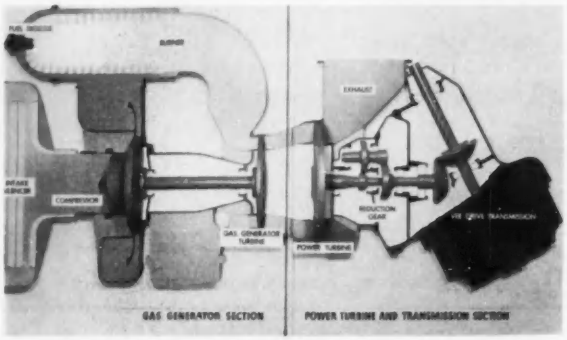


Fig. 1—This is a schematic of the gas turbine engine installed in GMC's Turbocruiser Coach

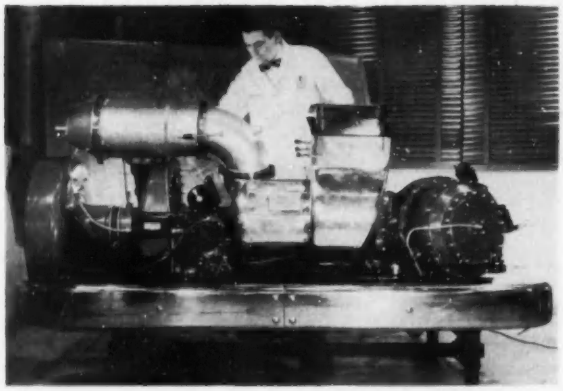


Fig. 2—And here is what the gas turbine for the bus looks like

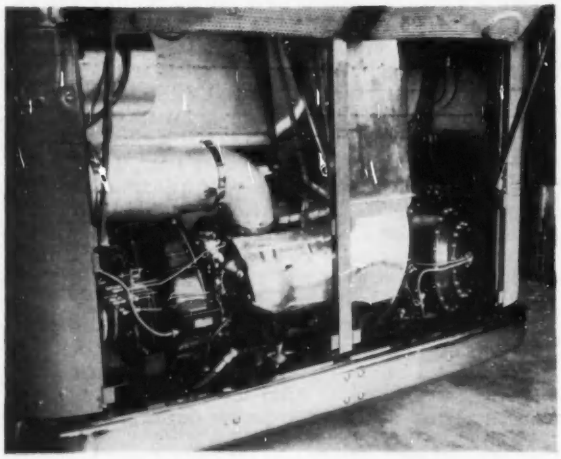


Fig 3—The gas turbine fits neatly in the bus engine compartment

A schematic of the final mechanical arrangement of the GT-300 Whirlfire engine is shown in Fig. 1. The engine can be conveniently considered as two mechanically independent components, the gasifier or gas generator section and the power turbine-transmission section. The only coupling between the two units is a flexible duct to transmit the working fluid from the gasifier to the power turbine.

The prime function of the gasifier is to provide hot compressed gas to the power turbine. In this respect it functions exactly like a small jet engine. Air enters the engine through the splitter-type, glass-fiber-lined silencer. The radial flow compressor discharges air through the single outlet air scroll to the combustor. A double walled elbow directs the hot gas from the combustor into the nozzle box and thence through the nozzle diaphragm and the gasifier turbine.

The combustion chamber is of the side entrance type, with the inlet located midway between the dome and the outlet. The burner liner is a conventional domed, can type with inlets suitably located for admission of primary and secondary air flow. A duplex type fuel nozzle is mounted in the center of the burner dome. The igniter plug, energized only during starting, is mounted on the side of the dome.

The sheet metal, single entrance nozzle box is welded to a one-piece cast nozzle diaphragm. The diaphragm, which includes the inner and outer shrouds and vanes, is precision-cast as a single unit by the shell molding process. Seventy-three precision-cast buckets are secured to the turbine disc by means of the familiar fir tree fastening.

All engine-driven accessories are in the gasifier section and are driven from the turbine shaft through a right-angle spiral bevel gear. Thus, the accessories are mounted at right angles to the turbine shaft. An automotive type starting motor using a conventional engaging mechanism is mounted on the high speed accessory shaft. This is used only to crank the engine and is disengaged during normal operation. In addition to the starting motor, the accessories include a tachometer-generator, a fuel pump, a gasifier lube pump, a power turbine lube pump and a power take-off suitable for driving an electric generator and service air compressor.

The gasifier lubrication system includes a full flow oil filter and provides solid jet lubrication to all high speed gears and bearings. Gravity scavenging is employed to return oil to the sump in the lower part of the accessory housing.

The construction of the power turbine nozzle diaphragm and wheel assembly is similar to that used in the gasifier turbine with 61 buckets on the power turbine wheel. The first pinion of the power turbine reduction gear is splined on the power turbine shaft. Three jackshafts, equally spaced around the power turbine shaft, carry the first stage gears and second stage pinions.

The Vee-type transmission is an adaptation of the

unit used in the GMC transit coaches. The torque converter, which is not necessary with a free shaft turbine, is removed and replaced by a set of constant-mesh, low-drive gears.

The power turbine exhaust passes into a collector mounted behind the turbine wheel. The entire hot part of the engine is enclosed in an aluminum radiation shield. The cooling air, drawn in over the faces of both turbine discs, is discharged within the radiation shield and is exhausted around the exhaust collector outlet.

The complete GT-300 Whirlfire Turbopower unit ready for installation is shown in Fig. 2. The silencer and the two engine sections complete with accessories and instrumentation fittings are mounted on a unit cradle. The whole unit is then mounted in an outer cradle for installation in the Turbocruiser Coach. High-frequency vibration isolators are provided between the inner and outer cradle to prevent transmission of engine noise to the coach body.

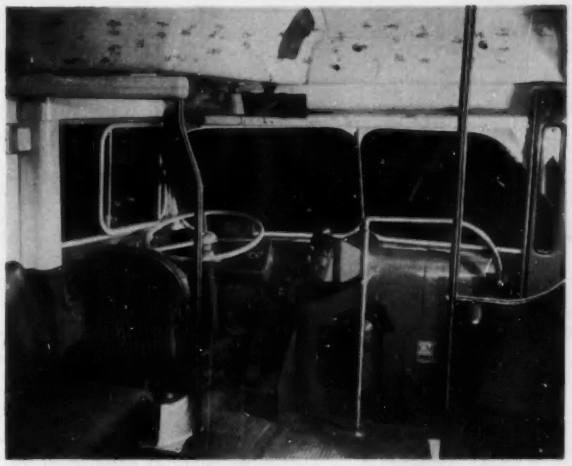


Fig. 4—The Turbocruiser Coach driver compartment looks pretty much like that of a conventional GMC coach. A few instruments have been added

It Goes Into Turbocruiser

A close-up of the engine installation in the Turbocruiser Coach is shown in Fig. 3. The gasifier compressor is in the left foreground, the single combustor directly above it, and the aluminum shielded exhaust duct and hot engine section to the right. A portion of the Vee drive transmission housing can be seen to the far right.

Very little change was made in the operator's instrument panel, as Fig. 4 shows. Two oil temperature indicators were added above the standard instrument panel to supplement the warning light system used with the diesel installation. An auxiliary instrument panel indicating nozzle box temperature, gasifier speed, and fuel system pressure is provided to monitor engine operation and serves as an aid in starting. An emergency stop button is provided in the event that any undesirable operating condition should be observed.

All special test instrumentation indicators are installed in a console extending across the rear of the coach. Seats for two observers are provided to expedite data recording. The instruments include a multi-point temperature indicator, vibration meter, speed indicators and counters, fuel and lube system pressure gages, and precision multi-point diaphragm pressure gages for high and low ranges. Short-run fuel consumption is measured by a weigh tank system. The instrumentation is nearly as complete as a standard test cell installation and supplies data not usually obtained from an operating vehicle.

2. Here Is What the Car Engine Is Like

Before the GT-300 engine could be installed and tested in a vehicle, another version of this engine was built. The new model, designated the GT-302, is shown schematically in Fig. 5. The design objective of this engine, to be installed in the XP-21 Firebird, was to utilize all the major components of the GT-300 engine in as compact a unit as possible without any change in the generally conservative engine design philosophy.

The space requirement of the single combustor on the GT-300 was unacceptable. So the new design incorporated a two-burner gasifier unit with a transmission specially designed for the Firebird.

To keep the overall size of the engine to a minimum, the combustors had to be kept as close to the shaft centerline as possible. The scheme by which this aim was accomplished is shown more clearly in Fig. 6. The dual outlet air compressor scroll terminates in cylindrical sections integral with the compressor housing and parallel to the centerline of the turbine shaft. Thus, the compressor housing forms the center section of the outer combustion chamber. The outer combustion chamber shell is completed by the domed end, the cylindrical expansion joint section, and the double walled outlet elbow. The fuel nozzles and igniter plug are mounted as shown on the combustion chamber dome.

All of the parts and accessories required to complete a GT-302 gasifier assembly are shown in Fig. 7. The screened air inlet incorporates an aluminum finned tube oil cooler to provide the necessary oil

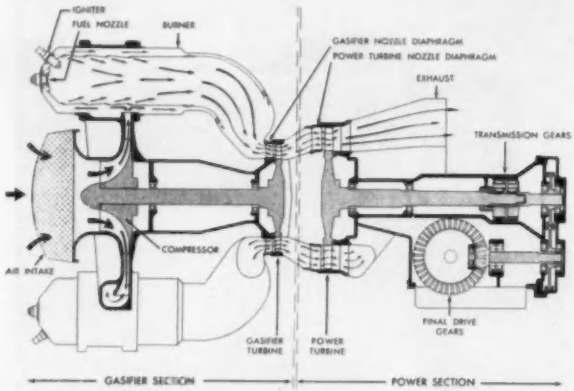


Fig. 5—Space limitations in the Firebird car forced an alteration of the bus powerplant, with the accent on compactness. As many of the GT-300 major parts as possible were retained for the GT-302 version

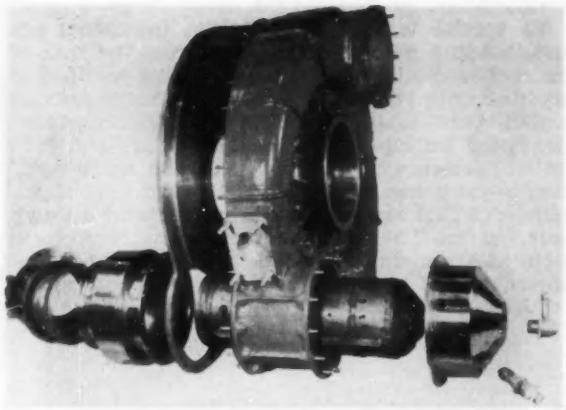


Fig. 6—Keeping the combustors close to the shaft centerline helped shrink the size of the engine package

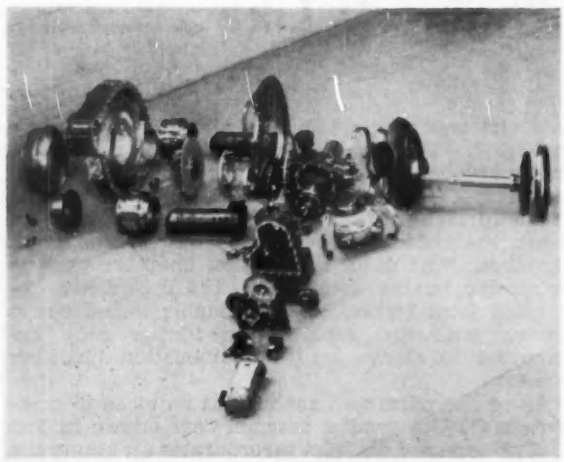


Fig. 7—Gasifer Section of the GT-302 engine

cooling capacity. The other principal departure from the GT-300 gasifier is the use of a starter-generator, which eliminates the starting motor engaging mechanism and provides energy to recharge the batteries. The accessory housing and drive assembly was also redesigned to make it more compact.

The power turbine wheel of the GT-302 engine, shown in Fig. 8, is the same as that used in the GT-300 engine, but the balance of the components for the power turbine-transmission assembly are entirely new. The power turbine shaft runs on two bearings mounted in a flanged cylindrical, cartridge-like housing. The turbine rotor and bearing cartridge assembly can be removed from the transmission assembly as a unit.

Special Transmission Built

The transmission assembly, designed by General Motors Engineering Staff Transmission Development Group, provides gear reduction from power turbine speed to wheel axle speed with driver-selected gear ranges including, "Park", "High", "Performance" and "Reverse." This design successfully resolves unique problems of planetary gear trains and pinion bearings operating at speeds much higher than previously encountered.

No neutral is provided, the transmission remaining in "High" gear when the "Park" pawl is engaged. Thus the power turbine wheel is always connected to the rear wheels to eliminate the possibility of a turbine runaway that might occur if neutral were provided. This feature is further enhanced by the spring applied "High" gear train brake assuring a safe operating condition in the event of hydraulic failure. The "Performance" setting on the transmission provides for acceleration in a lower gear range. Shift to "High" gear occurs automatically at a predetermined speed.

The right angle drive gearing and differential normally housed in the rear axle is enclosed in the transmission housing. However, no differential is used in the Firebird installation. Universal jointed rear axles transmit the power to the rear wheels and are installed after the power plant is secured to the chassis. The hydraulic system operates all shifting procedures in addition to providing lubrication and cooling for the complete power turbine-transmission assembly. An externally mounted oil-to-air heat exchanger provides sufficient cooling capacity for all operating conditions.

GT-302 Wed to Firebird

The complete GT-302 Whirlfire engine ready for installation into the Firebird chassis is shown in Fig. 9. The exhaust discharges horizontally in a semi-circular annulus above the transmission assembly. All of the hot parts of the engine are enclosed in aluminum radiation shielding ventilated in the same manner as in the GT-300 engine. The gasifier and power sections are independently mounted on a light box section frame of which the compressor case itself functions as a major cross member.

The unit construction of the powerplant greatly simplifies vehicle installation. A three-point mount-

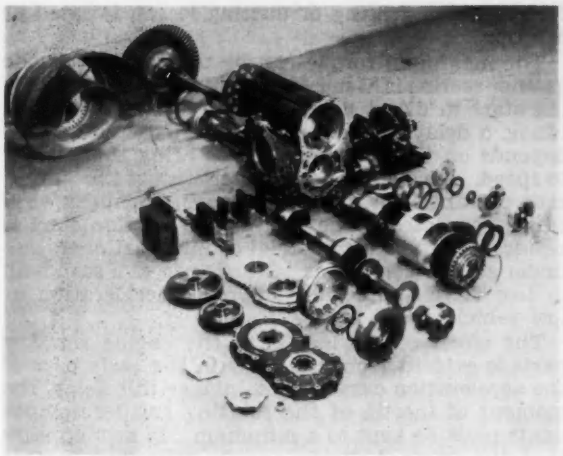


Fig. 8—Power section of the GT-302 gas turbine powerplant

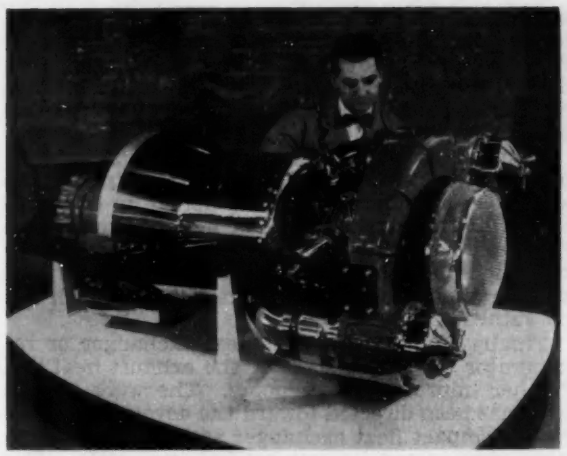


Fig. 9—Assemble the parts shown in the previous two illustrations and you have the GT-302 Whirlfire engine, all set to be installed in the Firebird car

ing system utilizing resilient, high-frequency vibration isolators is used. Quick disconnect couplings in the fluid and electrical leads minimize engine installation and removal time.

The engine installed and ready for test operation in the Firebird is shown in Fig. 10. The exhaust duct extending from the turbine exhaust collector to the rear of the Firebird is supported on the engine frame. The exhaust outlet is sized to minimize engine back pressure and reduce form drag of the body. The engine exhaust collector discharges into the exhaust duct with an eductor effect to carry away ventilating air from the radiation shield and engine compartment.

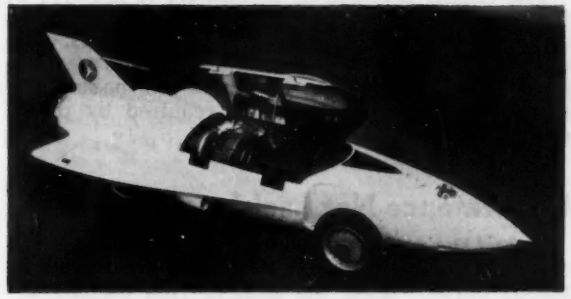


Fig. 10—With its engine installed, the Firebird is ready to take to the road

3. Here Is What Turbine Tests Showed

Before either the Firebird or the Turbocruiser installations were made, considerable dynamometer testing of both models was accomplished. As both units have the same rotating parts, work on either model was largely applicable to both. However, as operation of a heavy duty commercial vehicle differs from a light, high performance vehicle, it was felt that both installations would have to be made to obtain information in both areas.

Experience to date with the Whirlfire engines is based on over 1000 hr of dynamometer operation and over 2500 miles of test driving in the Firebird and the Turbocruiser. The bulk of the mileage, however, has been in the Turbocruiser.

Fuel Wants Can Be Curbed

At the outset of the program, it was recognized that many problems would arise in the development of this powerplant. It was decided, therefore, that mechanical simplicity would be emphasized on the first design so that these various problems could be pinpointed. These would then be dealt with in a later design. Consequently, an open cycle unit without regeneration was built, as high fuel consumption was only one item on the list of anticipated disadvantages of the gas turbine in an automotive installation.

At design point, an open cycle gas turbine with modest operating temperatures and pressures has a brake specific fuel consumption about twice that of its piston engine counterpart. Further, at part throttle, the fuel economy deteriorates more rapidly than in a piston engine. The question immediately arises, "What can be done about this?"

The approaches to improved fuel economy were outlined in the paper presented to SAE in 1949 and are essentially unchanged today.

First is a continuing improvement in component

efficiencies and a reduction in internal pressure losses. Any improvements in these are immediately reflected in improved specific fuel consumption. Secondly is the raising of operating temperatures. Much work has been done in this area by General Motors Research.

A new high temperature alloy, GMR 235, developed by the Research Metallurgy Department, has shown great promise in raising operating temperatures. This material has been incorporated in the first design, and the engine under the present design conditions has shown no indication of being temperature limited. It is therefore felt that much can be gained in this area.

Finally the addition of a heat exchanger or regenerator to recover some of the exhaust heat will further improve fuel economy. The work in this area has been directed toward the development of a light, compact heat exchanger with good effectiveness constructed of non-critical materials. The work at General Motors Research on the ALDIP process has shown definite promise toward an effective solution to this problem.

The engine is relatively insensitive to the type of fuel it can consume. A broad range of fuels can be used ranging from gasoline to the diesel fuels. Octane numbers and cetane numbers have no meaning in the gas turbine. The fuel must still possess the same degree of cleanliness as required by piston engines.

Performance Not Lacking

One of the features of the gas turbine that is very desirable in a vehicular power plant is its favorable torque curve. With the dual or free turbine arrangement, the engine produces maximum torque at stall as shown in Fig. 11. This stall torque, which is over twice that of design point torque, decreases almost linearly with increasing output shaft speed. It will be noted that the horsepower curve does not peak sharply, presenting maximum power over quite a broad range of shaft speeds. At present the engine, with all accessories loaded and no correction for reduction gearing or ducting losses, is rated at 370 hp.

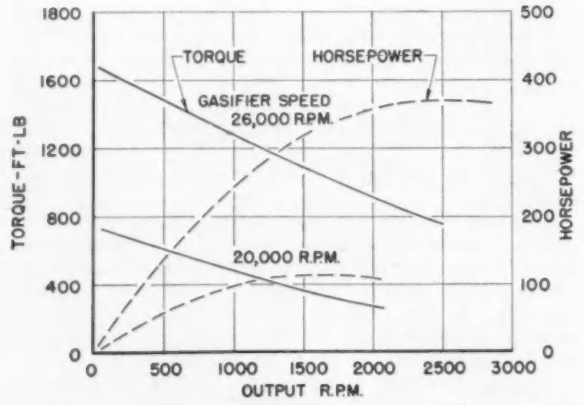


Fig. 11—Performance curves for the GT-302 engine reveals desirable torque and horsepower characteristics. The engine has high stall torque and maximum horsepower over wide range of shaft speeds

The maximum torque can be utilized only if the gasifier section is at maximum speed. From a standing start in direct drive, with the gasifier initially idling, a delay in acceleration is experienced which depends on the time required to bring the gasifier to speed. Acceleration characteristics of the Turbocruiser transit bus, shown in Fig. 12, exemplify what can be expected. The overall acceleration time is better than in its commercial counterpart operating under similar conditions. Starting from a standstill in low drive appreciably improves acceleration at low vehicle speed.

The effect of the inertia of the engine rotating parts is evident from the delay in the early part of the acceleration curve. To minimize this delay, the moment of inertia of the rotating gasifier components must be kept to a minimum. It now appears that the original design can be improved in this respect. Experience indicates that the limiting acceleration temperature can be raised appreciably above design temperature without any adverse effects. This will also help to decrease acceleration delay.

The acceleration is extremely smooth, entirely without any jerks or jolts. Further, the power is applied so smoothly that the maximum coefficient of traction can be maintained.

Because the combustion and expansion processes in a gas turbine engine are continuous, the average gas temperatures, and consequently the exposed metal temperatures, are high.

The lack of suitable materials long delayed the advent of the gas turbine, even though the first patents were taken out prior to those on conventional piston engines. The design operating temperature of the Whirlfire engine was set at 1500 F since this appeared reasonable in view of long life requirements. Operating experience with the engine, however, has proven that this temperature is very conservative.

Despite high metal temperatures, the installed engine does not pose any heat problems. The aluminum radiation shield which surrounds the hot zone of the engine has proved extremely effective. In the Firebird installation, the aluminum radiation shield has proved more than adequate to protect the plastic body, in many places less than 1 in. away. The compartment temperature in the Turbocruiser installation is no higher than with the usual diesel installation.

A Glutton for Air

To limit the operating temperatures to get reasonable life of the parts exposed to the hot gases, the overall air-fuel ratio of a gas turbine engine ranges from about 100 to 1 to 50 to 1. So the specific air consumption of a gas turbine is four to ten times that of a reciprocating engine, depending on the operating efficiency. The air handling ducts, both on the inlet and outlet of the engine, are larger in the same proportion and require an entirely new design concept in the engine installation.

The air filtering requirements are considerably less stringent in the gas turbine than in the conventional piston engine. Thus far the engines have

been operated entirely without air filters, and the only ill effects noted have been some erosion on the aluminum compressor and diffuser caused by the passage of sand particles. Experience indicates that the air should be strained rather than filtered to keep out the large particles.

Can Cool Exhaust

The Firebird was not designed to be used on public highways allowing horizontal discharge of the exhaust gas, which is desirable both from an engineering and styling standpoint. However, the hot gases diffuse very rapidly and at idle one can stand quite close to the outlet without discomfort.

The exhaust pipe could be made considerably smaller, even though all the cooling air of the engine compartment, as well as the engine exhaust, is funnelled through it. In this first installation, minimum pressure drop is maintained in the exhaust system. Although this is a very desirable condition, it may have been an unfortunate choice in view of the misunderstanding of the problem that this large exhaust may have promoted.

In the transit coach installation the exhaust is discharged vertically. This appears to be more practical in commercial type vehicles. The gas turbine, due to the large volume of excess air required to keep operating temperatures within reasonable limits, has a clear exhaust, free from carbon monoxide. In the Whirlfire installations, the exhaust shows no smoke or discoloration through the entire speed range.

Controls Are Simple

Engine speed and output is regulated in the engines by controlling the amount of fuel supplied to the gasifier section. This is accomplished in both the Firebird and the Turbocruiser installations by a needle-type fuel control valve actuated by a conventional accelerator pedal.

Only the transient condition of operation must be monitored, as a sudden surge of fuel to the engine at low speeds could cause an over-temperature condition while the gasifier adjusts its speed to the new fuel setting. A simple acceleration limiter is used which controls the rate at which the fuel is introduced to the engine during speed increases. Essentially this is a fuel by-pass regulated by compressor pressure. By adjusting this by-pass, the maximum acceleration temperatures and the rate of acceleration can be maintained at any desired level.

In both installations, this control has worked very satisfactorily. Speed can be maintained at any desired level without any special precaution. From the operator standpoint the control of the engine is equally as convenient as is any piston engine installation.

Silencer Muffles Noise

Noise level is usually placed high in the list of disadvantages of the gas turbine engine. In the initial paper study, this disadvantage appeared very significant, based largely on jet engine experiences. The unmuffled version of the gas turbine engine is indeed noisy.

However reduction of the noise level of these engines did not pose as great a problem as first anticipated. Most of the noise, at least the most disagreeable noise, emanates from the air inlet to the compressor. This is of high frequency, between 2,000 and 7,000 cps, and can be very satisfactorily absorbed by many available materials.

In the transit bus installation, a very elementary splitter-type silencer reduces engine inlet noise to an acceptable level. The exhaust noise, on the other hand, is of comparatively low frequency, 150 cps, where a resonator-type silencer would be more effective. In the Turbocruiser, only an intake silencer is used, the exhaust being unmuffled. The results are surprisingly good and the noise level of this installation compares rather favorably with its commercial counterpart. The Firebird is entirely unmuffled. Although the noise level is higher than in the muffled bus version, it is not too objectionable as the body shell attenuates the noise to some degree.

Guard Fast-Spinning Parts

One of the first things that strikes the uninitiated about the gas turbine engine is the high speed of its rotating parts. In working with gas turbines, one uses 1000 rpm increments in the same manner as 100 rpm steps are used with the piston engine. Although the speeds are high, the ratio between idle and maximum speed is about the same as in

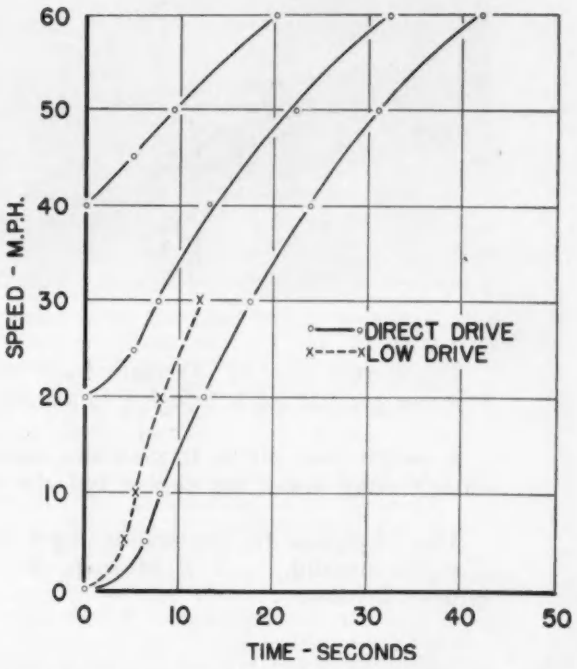


Fig 12—Acceleration characteristics of the Turbocruiser Coach shown here are better than those of the commercial version of the vehicle

diesel practice. The idle speed of the gasifier is usually set at about 8000 rpm and the maximum speed is 26,000 rpm.

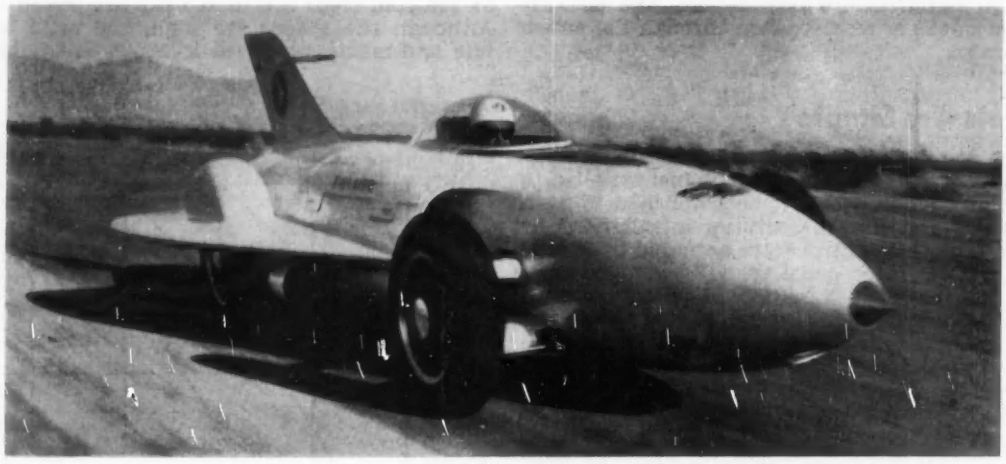
The gyroscopic effect has been minimized in the Whirlfire engines by designing the two turbines to rotate in opposite directions. The gyroscopic moment at design point is thereby reduced to a very small value and is a maximum with the gasifier at maximum speed and the power turbine stalled.

The actual magnitude of the gyroscopic effect might best be visualized by assuming a vertical pitch frequency of 100 cpm with an amplitude of 2 in., as might be induced through the suspension of a moving vehicle. Under the most severe conditions, this would result in a gyroscopic moment of 525 in.-lb in the horizontal plane. This would have little effect on control of the vehicle.

Another question that arises is, "How safe is a unit rotating at these speeds?" The shrouds surrounding the turbine wheels on the Whirlfire engine are made from steel forgings heavy enough to contain any bucket fragments. The most serious failure which might occur is a burst turbine disc. To minimize this possibility, the discs are designed with a large margin of safety. With proper design

Next Month . . .

Genesis of the Firebird!



The August issue of SAE Journal will feature a report on the new engineering look that the gas turbine is bringing to passenger cars.

A switch from piston to pinwheel power brings with it a metamorphosis of the chassis slung under the engine and the body wrapped around it.

This challenge to engineering ingenuity will be reported by men who have met it in the Firebird . . . R. F. McLean and Robert Schilling, of GMC's Research Laboratories Division.

considerations such as these, the gas turbine is as safe as any contemporary engine.

Engines Stand the Gaff

The Whirlfire engines have proved to be very rugged and only one major failure has thus far been experienced. A blade of a cast compressor inducer failed after 10 hr of operation on the dynamometer. This condition was remedied by machining the part from an aluminum forging. Since proper forging and machining techniques were established, no further failures have been experienced.

One surprising feature of the unit has been its ability to absorb foreign material. On several occasions pieces of special instrumenation have passed through the machine. The turbine buckets were bent, but in no instance did they fail, even after subsequent running of the damaged parts.

The engine is very easy to maintain as each of the major components can be removed and serviced as a unit. Further, it is possible to replace damaged turbine buckets on the engine without disassembly. The design of the combustion chambers is such that the fuel nozzle and inner liner can be removed, inspected, and reassembled in a few minutes.

As the drives for the engine accessories are at right angles to the main shaft, the accessories can be removed individually with little difficulty. This arrangement permits a wide variety of accessories to be used as length is not a governing criterion. For example, on the transit bus installation an extension shaft is connected to one accessory shaft to drive a remotely located generator and air compressor.

Takes 20 Seconds to Start

Both models of the engines are very easy to start. The model GT-300 engine uses a standard 12-v starting motor while the GT-302 installed in the Firebird uses a 24-v starter-generator.

In both cases the starting time and sequence is the same. The starting motor and the ignition system are energized. The gasifier section is brought up to 3000 rpm and the solenoid valve in the fuel line just ahead of the nozzles is opened. Combustion then begins and the starter is held on until the gasifier reaches about 6000 rpm. The entire sequence requires about 20 sec. Although no extreme cold weather starts have yet been attempted, it appears that this engine should be quite easy to start even under sub-zero conditions.

Rough on Brakes

Much has been said about the lack of engine braking in the gas turbine engine and all the speculation is generally correct. In neither installation, the Turbocruiser nor the Firebird, does the engine supply any appreciable braking during deceleration.

The Firebird scoots along rather briskly with the gasifier idling once the vehicle is accelerated to speed. This imposes rather severe requirements on the vehicle brakes. It appears that some sort of supplementary dynamic braking device may be required. One example of this is the flap brake system used on the Firebird.

It is possible, however, to have the engine supply braking in special cases. If the vehicle is descending a steep grade, the transmission can be shifted to reverse. This causes the power turbine wheel to turn backwards; and with the gasifier speed selected to maintain proper retarding torque, the vehicle can descend at any speed desired without resorting to the vehicle brakes. This might be very desirable in a commercial vehicle handling heavy loads over steep terrain. In this particular instance, at least the free-wheeling characteristics are actually an advantage.

Motor Oil Satisfies Bearings

In a commercial installation with present operating temperatures, the lubrication requirements of the gas turbine do not appear very severe. For one thing, the lubricant is never exposed to the combustion area or to the products of combustion.

The oil, in addition to providing lubrication, is used to cool the high speed bearings. Silver plated retainers are used in the roller bearings and the ball bearings on both turbine shafts. Bearing experience thus far has been very good as the first failure has yet to occur.

In all cases these high speed bearings are jet lubricated. Oils with rather low viscosity and with little tendency to foam are used, and experience has indicated that commercially available premium motor oils will fill these requirements.

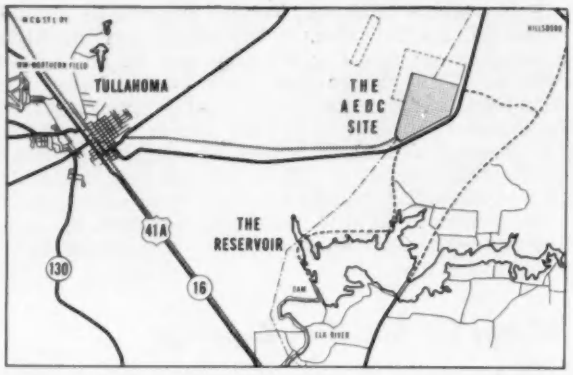
As operating temperatures are increased, the requirements of the lubricant become more stringent, as it then must withstand the "soaking" condition to which it may be exposed. When the unit is shut down, the heat from the hot zones soaks through the shaft into the bearings and may cause the oil to coke if these temperatures rise above the limiting temperature of the oil. On a subsequent start, the coke and carbon would have an adverse effect on the bearing. This condition, however, has never been experienced with the Whirlfire engines. Further, in these engines the oil consumption is so low that it has not been measured. The greatest loss is through the engine breather pipe and has been minimized by proper design and location of the breather.

Lightweight with Heavyweight Punch

One of the greatest advantages of the gas turbine engine is its favorable weight to power ratio. The entire power package for the Firebird, which includes the transmission and final drives, weighs only 775 lb and gives the powerplant and drive a weight to power ratio of approximately 2 lb per horsepower. This ratio is about one-third of a conventional piston engine and drive.

In the Turbocruiser installation, the gas turbine engine, in addition to supplying nearly twice as much power as the diesel normally used, saves over 1500 lb in engine weight. In both cases this saving in weight has been accomplished without sacrificing strength of the components. Automotive rather than aircraft design practice is followed throughout.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



Arnold Engineering Development Center is 12 miles from Tullahoma, in central Tennessee, about half way between Chattanooga and Nashville. Cooling water is pumped to site from 12-mile-long reservoir

AEDC Provides

THE Arnold Engineering Development Center at Tullahoma, Tennessee, provides a complete Engine Test Facility for advanced aircraft engines.

It is designed for full-flight operation of turbine and ramjet engines in test chambers. Inlet and exhaust conditions allow both performance and endurance testing from sea level to 80,000 ft.

The Arnold Engineering Development Center is one of eight the Air Research and Development Command operates. Besides the Engine Test Facility (ETF), the Arnold Center includes a Gas Dynamics Facility and a Propulsion Wind Tunnel. All three are shown in the sketch at the right.

The ETF is managed and operated by a private corporation, ARO, Inc., under contract to the Air Force. ETF's services, and those of the other two facilities at the Center, are available to the Air Force and other branches of the military services and to industrial organizations and educational institutions engaged in propulsion and aeronautical research and development.

The three facilities at the Arnold Center provide for testing

turbojets
ramjets
turboprops
supersonic aircraft
guided missiles

No provision is made for testing reciprocating engines because there are adequate facilities available elsewhere. Rocket engines could be tested, but the high temperature of the exhaust and the contamination it produces would make this difficult. It is expected, however, that new uses for the equipment will be found as advanced engine types are developed.

Much of the ETC's equipment came as war reparations from the B.M.W. (Bavarian Motor Works) engine test plant at Munich. In 1943 B.M.W. completed the test plant that served for development of the successful German jet fighter engines. At the end of World War II machinery for a second version of the plant was completed but not installed.

After the war, the plant was set up by German engineers for American and British test purposes. Some of the English jets ran there. Later the plant was dismantled and shipped to the United States.

Now the B.M.W. equipment has been combined with much additional U.S.-built equipment at the Arnold ETC.

American and German engineers at Wright Field planned the ETF, with the help of American engine manufacturers, after extensive studies of the German test plant and our own engine development needs. The laboratory was included in the Air Engineering Development Center authorized by Congress late in 1949. (The name was changed to Arnold Engineering Development Center after the death of General "Hap" Arnold.)

The $170,000,000 or more appropriated by Congress for AEDC has been applied to make it an engine developer's dream, complete with all the electronic devices, electric power, and other equipment needed for speedy, thorough testing.

For example, automatic data reduction devices make test results available in usable form at the test cell within 30 sec after the data are taken. This system transfers all measured temperatures, pressures, electrical outputs, and motions to digital form. Then it automatically computes and prints or plots final corrected results. A tape record also stores all the raw data.

Having test results at hand so soon makes it easy to schedule the next test points accurately and without delay.

Electric power comes from the Tennessee Valley Authority. Pressurized underground cables lead the current from high towers directly to each facility. The facilities have their own substations for reducing voltage to 6600v, 440v, and 110v.

Power for emergency use is generated by steam turbines within each laboratory. A huge steam plant supplies steam for this purpose as well as for heating.

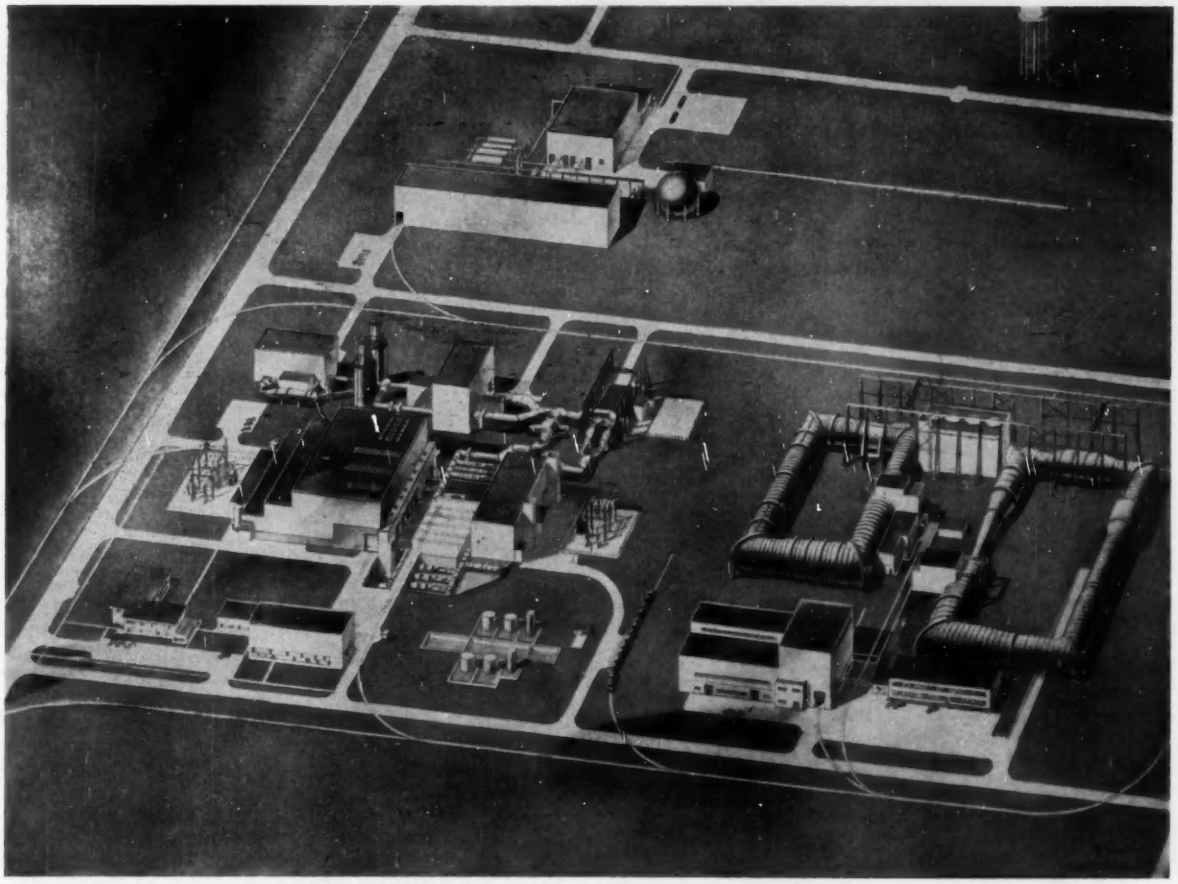
Water comes from a reservoir 3 miles south of the Center. A primary pumping station forces the water at rates up to 100,000 gpm into a reservoir on the AEDC site adjacent to a secondary pumping station. The secondary pumps will supply 150,000 gpm directly to any test facility at 50 psi pressure.

On the next and following pages are shown sketches of the turbine engine and ramjet test installations of the Engine Test Facility as they were expected to look on completion.

Huge Jet Engine Test Facility

Gaylord W. Newton, ARO, Inc.

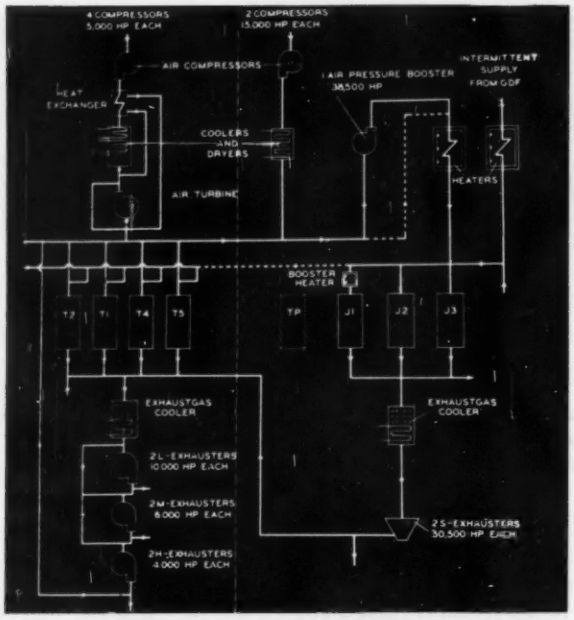
Based on paper "Simulated Flight for Engines at AEDC" presented at SAE National Aeronautic Meeting, New York, April 23, 1953.



At lower left is Engine Test Facility (ETF) and the Ramjet Addition (RJA). Behind it is the Gas Dynamics Facility with the sphere which is evacuated to help develop a pressure differential across a small wind tunnel and its long pipe for holding an intermittent air supply.

Propulsion Wing Tunnel is on the right. Left circuit is transonic and right circuit supersonic. Building beneath crane houses electric motors providing 216,000 hp to drive compressors.

Not shown are an administration building, model shop, steam plant, electrical substations, pumping stations, and the secondary reservoir.



ENGINE TEST FACILITY, including Ram Jet Addition can test turbojets, ramjets, and turboprops.

Air from the four 5000-hp compressors at the upper left passes through a heat exchanger and then a cooler. The cooler takes out moisture and emits the air at a temperature below freezing.

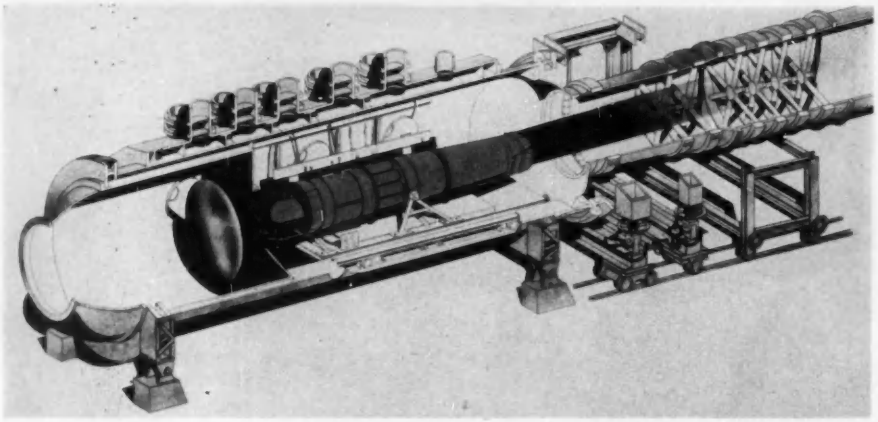
If still colder air is required, it passes through a refrigeration turbine. If warmer air is required it goes instead through the heat exchanger to pick up the heat of compression. Valves mix the air to the desired temperature.

The air can also be led to the RJA heater, then returned to the T1, T2, or T4 test chambers or the T5 test area or it can be combined with heated or unheated air from the RJA compressors.

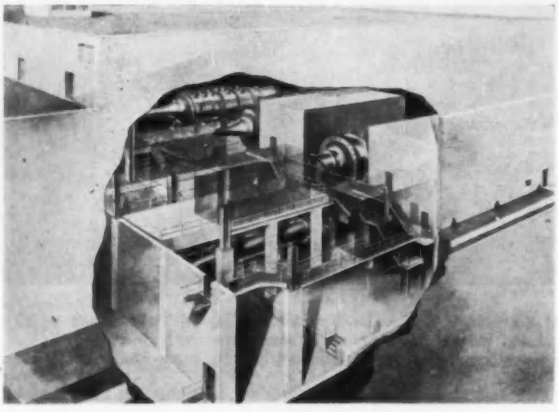
The T1, T2, T4, and T5 cells can take only part of the total compressor output, but the J1, J2, and J3 cells each can utilize the entire plant capacity for testing large ramjets.

The exhaust compressors simulate altitude conditions.

Turbojet Testing



IN TYPICAL TURBOJET installation, engine is mounted within the test cell on a thrust bed with quick-attachable provisions for instrumentation leads and controls. In case shown, engine inlet connects to bellmouth inserted through a labyrinth seal into plenum for smooth flow and easy thrust measurement. Water spray cools exhaust. Stacks on top are overpressure relief ports.



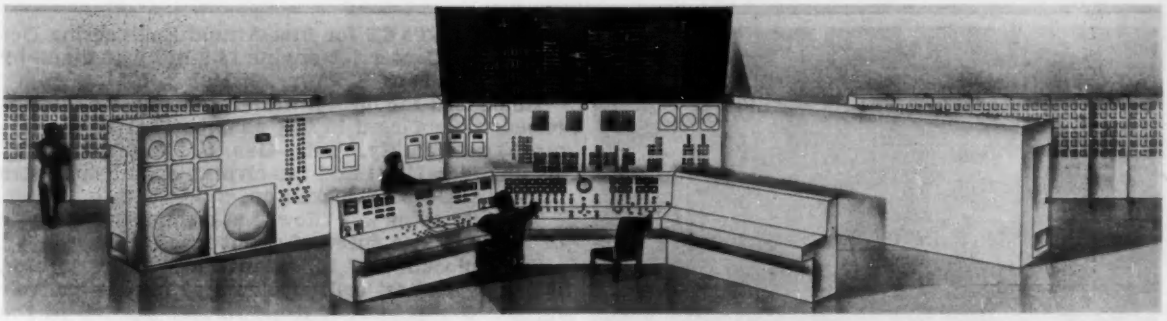
TURBINE TEST CELL building houses the T1, T2, and T4 test cells and the T5 test area. The air inlet for the T2 turboprop test cell (at the right in the sketch) enters on a lower level to leave room for installation of a dynamometer.

Tracks facilitate engine changing. Also, each cell is complete in itself so that as soon as one test ends, the air supply can be switched immediately to another cell.

Each cell has its control room where engine operating controls, air supply controls, and exhaust discharge controls are housed. Television screens show the operator what's going on at the engine. (There is no direct view.)

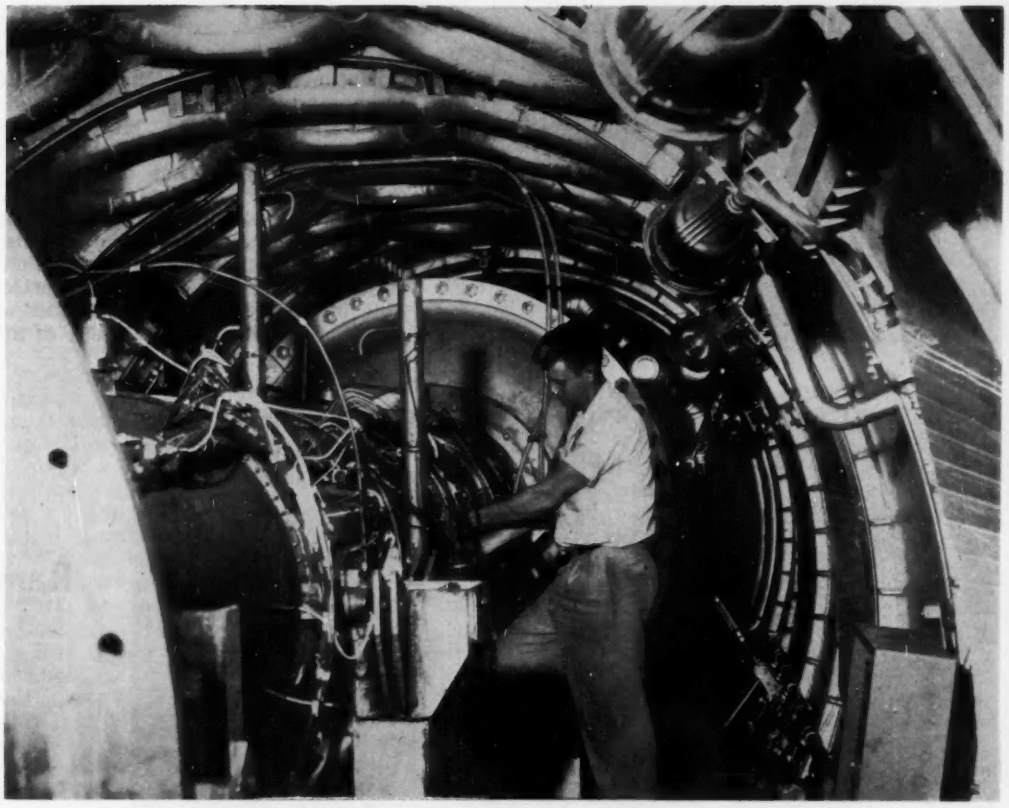
Manometer banks are installed so that their fluid levels can be recorded photographically.

All instrumentation is of the most advanced type.



MAIN CONTROL ROOM of entire Engine Test Facility gives chief operator control of all air compressors, exhausters, and auxiliaries. Lighted diagram above shows him circuits in operation and valve positions.

In a typical operation, the operator sets all valves for a particular engine test control room and starts all of the motors involved. He then phones the test cell's control room that they may operate within certain load limitations. Test technician controls engine under test as required. Chief operator controls 150,000 hp and 125,000 gpm of water altogether.



INSIDE TEST CELL an ETF engineer checks adjustments on a J-47 turbojet just prior to first simulated flight test of a jet engine to be held at the AEDC. Test was run May 3, 1954. First runs were for shakedown and calibration purposes.

Intake end of the turbojet is in the background. Beyond is the 20,000-hp bank of compressors which supply air to the chamber. At the exhaust end is the 40,000-hp bank of exhauster pumps which pull down exhaust pressure to simulate altitude conditions. Between the engine and the pumps is an exhaust diffuser, part of which appears at the extreme left.

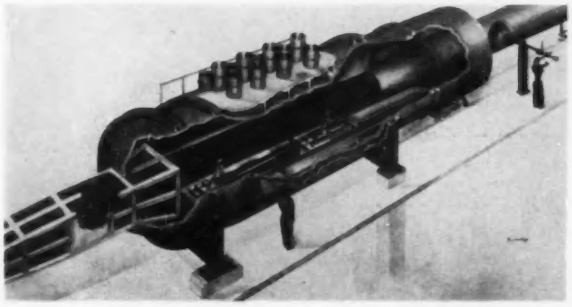
Cell shown is T-1. Two other test cells will be operating before the end of 1954, it is expected. The open test bed went into operation in March.

OFFICIAL START for first Arnold Engineering Development Center jet engine "flight" was made by Lt. Gen. Thomas S. Power on May 3, 1954.

He pushed the button which started a J-47 turbojet engine enclosed in test chamber T-1 of the Engine Test Facility. Brig.-Gen. S. R. Harris, AEDC commander, (left) and two civilian engine operators on the AEDC staff looked on.

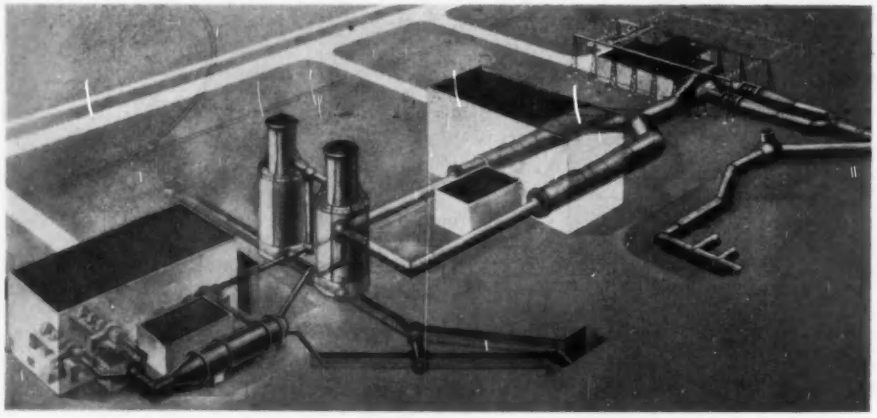
The jet engine was "flown" at a simulated altitude of 30,000 ft at a speed of about mach 0.7.

The "blockhouse" in which the men are located is beside the test cell. It contains all the controls for the engine plus controls for the portion of the airflow which has been assigned by the main ETF control room to this particular cell for this test. Test operator's job is greatly simplified and speeded up by automatic recording of almost all data.



RAMJET INSTALLATION is similar to turbojet installation except that the ramjet's higher exhaust temperatures require special water jacketing and water spray treatment. Here the engine is mounted on a thrust stand. The inlet is located behind a fixed nozzle supplying the proper mach number conditions for the engine.

Original plan called for fixed nozzles, although at supersonic speeds, separate nozzle is required for each value of mach number at which tests are to be run. Variable-mach-number nozzles may be available in the future. Fixed nozzles are mounted to permit some variation in angle of attack.



Ramjet Testing

RAMJET ADDITION consists of air compressor building (left), two large air heaters for heating intake air, the test cell building, and the exhauster building.

Either ramjet cell can use the entire plant capacity of the ETF plus that of the RJA. This is done by leading air from ETF to the RJA and combining it with air from the RJA's two 15,000-hp compressors. Their output can be directed through a second-stage, 38,500-hp compressor and then to a booster heater on the way to the ramjet test cell.

Altitude, flight speed, and engine fuel flow can be held constant for steady-state testing. Or any one—or all three—can be varied. This permits transient trajectory testing of advanced types of ramjets for guided missiles.

Designers Get Out of a Pickle with

Dual-Metal Centrifugal Casting

A. E. Schuh and M. L. Samuels,
United States Pipe and Foundry Co.

Based on a technical committee report prepared for Division XXXI—Centrifugal Castings of the SAE Iron and Steel Technical Committee

DUAL-METAL centrifugal casting can get designers of hollow cylinders out of material-selection dilemmas. It would appear that engineers are now in a position to use more simplified designs with no thought of a compromise material that fails to meet the full requirements. Dual-metal centrifugal casting gives a combination of properties not available from either base composition. The bonding process secures sound metal free from imperfections.

With this new process, parts can be cast centrifugally of two or more dissimilar metals, assuring a true metallurgical bond. (A true metallurgical bond is bound to result because the conditions for proper weldment are inherent in the process.)

Probably the best way to show what dual-metal centrifugal casting has to offer is to present six case histories of how it has been used to date. The dual-metal castings discussed in the first three cases that follow have proved their merit in actual service; those discussed in the last three cases have not as yet been subjected to prolonged field tests. There is adequate basis, however, for believing that they will also behave satisfactorily. They are cited at this time primarily to indicate the versatility of the dual-metal centrifugal casting process.

Case I—Grinding Rolls

For decades, rolls have been used to grind such things as flour, paint, ink, and chocolate. And for decades these rolls have been made by static casting a single material. By subjecting this metal to certain freezing conditions, it has been possible to get

Sees Automotive Uses for Dual-Metal Centrifugal Casting

FORD's Gosta Vennerholm, a member of ISTC Division XXXI, sees great possibilities for dual-metal centrifugal casting in the automotive field.

He feels that the process might be particularly suitable for making steel-backed brake drums and steel-backed wet cylinder liners.

Take the case of brake drums. First the steel back of the drum would be centrifugally cast, then seconds later one would follow this up with a layer of cast iron, he points out. In such a way, it might be possible to get a true metallurgical bond between the cast steel and the cast iron.

Cylinder liners could be produced the same way, with the same benefits, Vennerholm believes. For that matter, in cases where severe corrosive conditions exist, one could use a combination of stainless steel and ordinary steel.

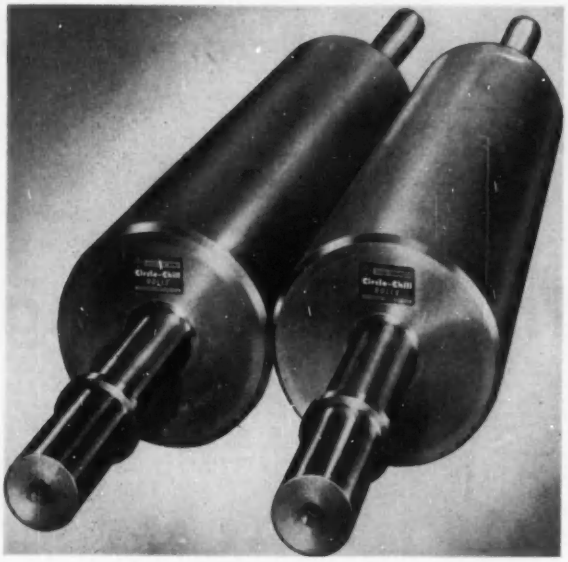


Fig. 1—Centrifugally cast dual-metal flour-mill grinding rolls have proved eminently satisfactory in service

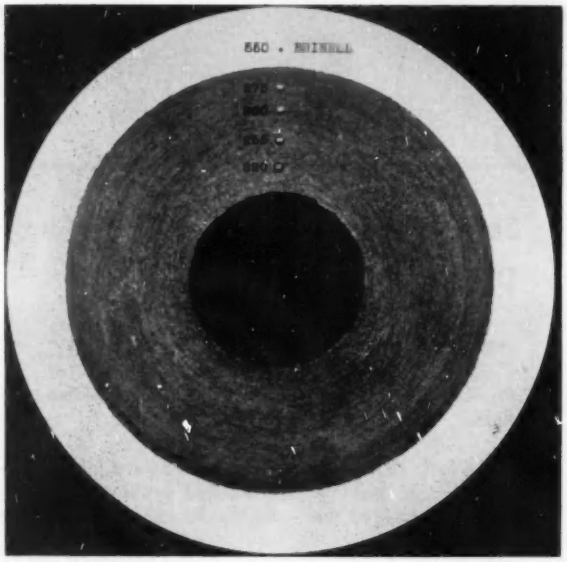


Fig. 2—This is a cross-sectional view of one of the flour-mill rolls shown in Fig. 1

a white iron outer layer, an adjoining region of mottled iron, and a core of normal gray iron.

Many satisfactory grinding rolls have been made in this manner, and likewise many unsatisfactory ones have also been produced. Grinding life of some rolls has not been up to standard due to variation in depth of chill. Other rolls have been difficult to bore due to the fact that cementite has been formed throughout the entire cross section.

Both of these difficulties, however, have been eliminated by utilizing dual-metal centrifugal casting. The outer part of the dual-metal rolls shown in Fig. 1 is cast from iron specially tailored to avoid the possibility of mottle structure formation. Chemical composition of this material is adjusted to produce a chill layer of controlled hardness and of a predetermined thickness. (See Fig. 2.) The inner portion of these rolls is cast from iron of quite a different composition: One that is free of unmachinable cementite.

As mentioned before, this casting process assures a bond as strong as the metals used. (See Fig. 3.) What's more, concentricity and thickness of the two layers is adequately controlled for the service required.

In summing up the advantages of such centrifugally cast dual-metal rolls, the following points should be mentioned:

1. Field performance has been excellent.
2. Depth of clear chill can be varied at will simply by changing the weights of hard and soft iron used.
3. The two irons come from separate melts; therefore compositional adjustment of either can be carried out without affecting the other.
4. Centrifugal force acting during the freezing interval assures a sound and dense outer chill layer.

Case II—Mixer Bowls

Mixer bowls have been used for years by the plastics, rubber, and allied industries for kneading, grinding, and mixing doughy materials.

Mixing is done at fairly high levels of power and relatively slow rotational speeds; hence the container must be made of a metal that is both strong and wear resistant.

Steel is normally used. But the materials mixed are usually sufficiently abrasive to wear the steel surface rapidly. As a result, the clearances between rotor and stator soon get too large. To overcome this, the inner surface of the steel drum has frequently been hard faced by welding on a layer of hard facing material which is relatively expensive. Also, at times, the bond between the two metals has left something to be desired. Finally, since this facing operation is of a manual nature, it requires considerable skill.

To surmount these difficulties, as well as effect economies, a centrifugally cast dual-metal combination was developed.

An all Ni-hard bowl, it was realized, could not be welded and would be too brittle to stand up under the comparatively harsh service. A steel-white iron combination seemed to be the answer. The outer layer of a bowl was made of steel, thick enough to permit welded fabrication and to cope with the mechanical stresses involved. The inner layer was a white iron material, Ni-hard or other hard white cast irons. This material fulfilled the erosion-resistant requirement. Fig. 4 shows a cross-sectional view of just such a mixing bowl.

Mixing bowls made this way have been in satisfactory use for a number of years.

Case III—Textile Rolls

In the textile industry, rolls of considerable heft are employed for impregnating dyes and finishes to

cloth. The surface of these rolls must be of a non-corroding, non-staining material.

Up until a few years ago, the standard method of fabricating these rolls was roughly as follows: A cast-iron roll of considerable weight or a heavy wall seamless tube was clad with stainless plate. This plate was preformed to the required curvature and seam welded, usually in three longitudinal segments, over the inner core. The ends were then welded to the underlying end of the core.

Two difficulties were encountered. Due to inadequate anchorage to the base roll, the stainless plate would either slip or crack at the weld. Also, the longitudinal weld seams—even though ground smooth to the point where the weld was difficult to see—would leave a transfer mark on the textile being finished.

The answer lay in the development of centrifugally cast composite rolls. These rolls today are cast with an outer layer of stainless steel (usually about ½ in. thick) and a massive inner core layer of gray cast iron. Fig. 5 shows one of these rolls; Fig. 6 shows the microstructure in the vicinity of the fusion zone.

Such rolls have been used with good results for several years.

Case IV—Slush-Pump Liners

Modern rotary drilling of oil wells requires the continuous circulation of specially developed muds. These muds must be pumped under relatively high pressures, particularly with deep wells. Obviously, the cylinder walls of such pumps are subjected to severe abrasion and, in certain geographic locations, these muds are corrosive. As a result, the life of pump lining is frequently very short.

Since down time in a well-drilling operation is costly, the search for a pump-liner material of superior performance has been going on a long time.

Recently there was developed a centrifugally cast dual-metal material, currently undergoing field tests. The outer part of this bimetallic cylinder is steel, the inner wearing part is high chromium (25–27%)—high carbon cast iron. (See Fig. 7.)

The combination of high hardness and corrosion resistance offered by the relatively high chromium content has to date yielded at least a tenfold increase in liner life. Additional experience is needed, however, before the full gain in life can be appraised.

Case V—Lift Pipe Sections

In cracking crude oils, large quantities of hot (1050 F) synthetic catalyst pellets are gravity fed from the top of high towers down through reaction and reactivating chambers. The pellets are then lifted pneumatically through a vertical pipe to start the cycle over again. (These lift pipes range from about 14¾ to 25½ in. ID and, in some cases, are as high as 325 ft.) Quantity of pellets moved ranges from about 90 tons per hr for smaller pipes to 400 tons per hr for the larger ones.

These pellets, particularly where they enter and leave the lift pipes, undergo a comparatively sudden change in direction of flow. The abrasive action that results has seriously shortened the life of the lift pipes at these points. This has meant costly shutdowns.

In an attempt to overcome this problem, a dual-metal centrifugally cast lift pipe has been developed. It consists of a sturdy outer layer of low-alloy steel, lined on the inside with an abrasion-resistant metal. (See Fig. 8.)

At present two different inner-liner materials are being field tested. One is Ni-hard, the other is a

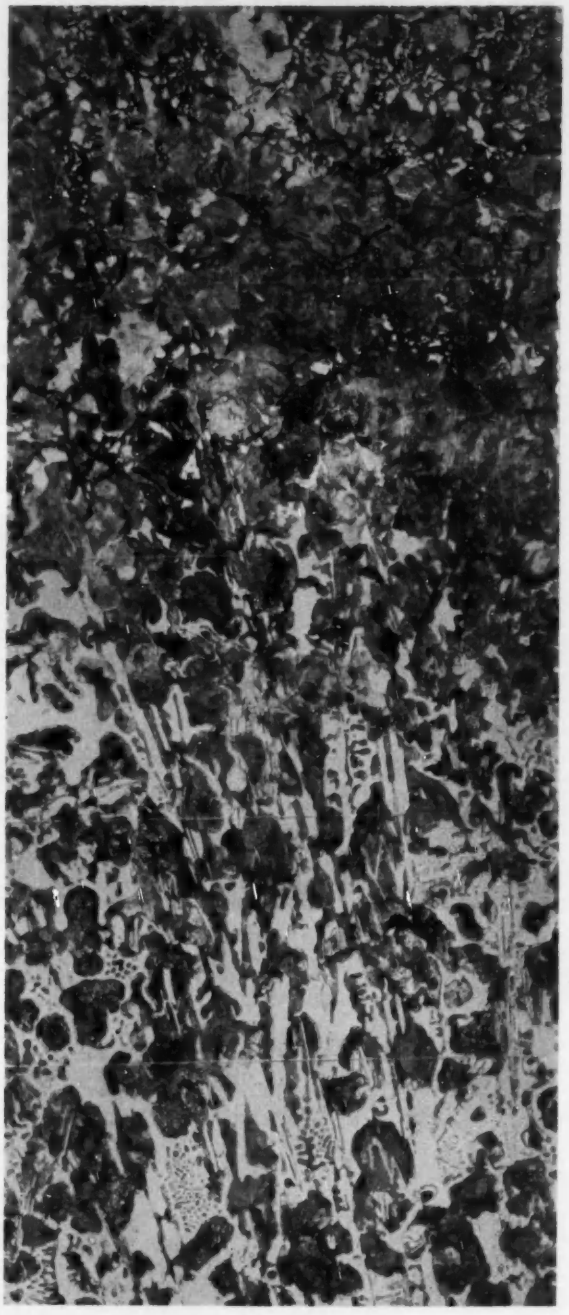


Fig. 3—Microstructure through the bond or fusion zone of the dual-metal flour-mill rolls shown in Fig. 1 (Magnification—100 diameters)

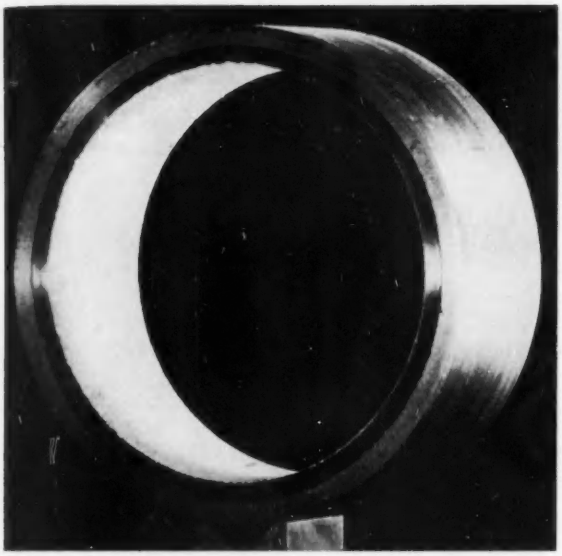


Fig. 4—This cross-sectional view shows a centrifugally cast dual-metal mixer bowl. Outer layer is SAE 1020, inner lining is Ni-hard white cast iron

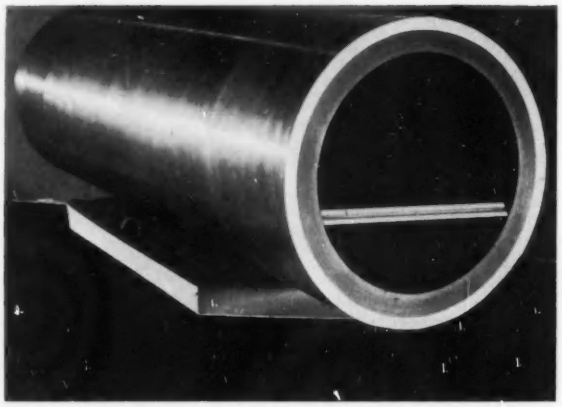


Fig. 5—Textile rolls, too, are centrifugally cast in two metals

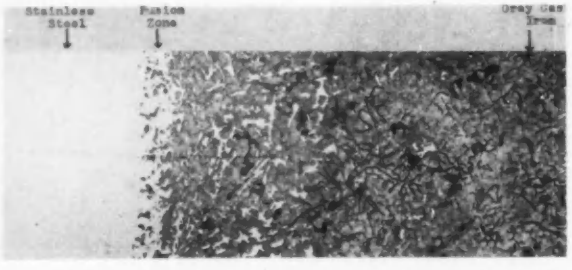


Fig. 6—Microstructure of a dual-metal textile roll looks like this in the vicinity of the bond or fusion zone (Etched—20 diameters)

high chromium (25–28%)—high carbon iron. The latter alloy (ACI HC 250) has shown negligible wear after nine months in service. (Fig. 9 shows the metallurgical bond between the two metals.) There has been no opportunity yet to evaluate the Ni-hard-lined castings.

Case VI—Chemical Pressure Piping

In chemical processing, there are numerous instances where tubular containers must have both high strength and a high order of chemical inertness. To satisfy this need with a single material would require such heavy wall thickness that prohibitive cost would be involved.

One possible way to get around this would be to use a dual-metal casting. The major part of the wall section could be a relatively inexpensive low-alloy steel, say SAE 4120, the interior liner a stainless austenitic steel. The ratio of wall thicknesses could be 3 or 4 to 1, in favor of the lower cost material.

Such a dual-metal centrifugal casting is currently under development.

Composite centrifugally cast billets 5¾ in. in diameter have been hot- or cold-reduced in progressive steps to about 1-9/16 in. diameter. The attendant reduction in wall thickness has been from 11/16 to ⅛ in.; length has been increased roughly 40 times over that of the original billet.

Most important of all, however, is the fact that the bond has held up satisfactorily under this process of successive reduction. This, in itself, is a pretty strong testimonial to the quality of the bond between the two steel layers.

It would be possible, of course, to reverse the posi-

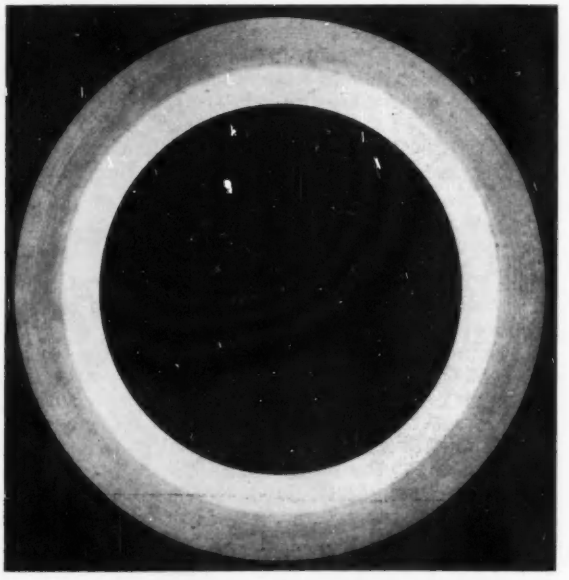


Fig. 7—Centrifugally cast bimetallic slush-pump liners are currently being field tested and evaluated

tion of the two dissimilar steel sections. For that matter, when facilities for reducing larger diameter billets become available, there is no apparent reason why a triple layer—with stainless on both surfaces —cannot be made available.

Owing to the difference in response to heat-treatment, these dual-metal castings can be given high strength levels. A suitable quench can raise the strength of the low-alloy steel to a high level without affecting the austenitic stainless material.

The potential value of dual-metal centrifugal castings in high-pressure chemical manufacturing is obvious.

It should be apparent that many possibilities for successful applications of this process exist which have not yet been entertained due to its relative newness.

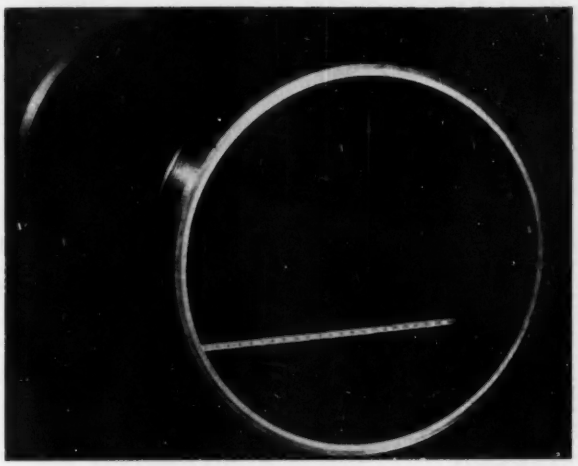


Fig. 8—Dual-metal centrifugally cast lift pipes seem to be the answer to a crude-oil refining problem

Process Won't Solve All Problems

It should be pointed out, however, that dual-metal centrifugal casting offers no panacea to design engineers.

Certain limitations exist. The outer metal of a dual-metal hollow cylinder cannot be substantially lower in melting point than the inner material. For instance, combining a lower melting point metal such as copper, brass, or bronze inside a steel outer cylinder is quite feasible. Reversing the position of these metals, however, would not permit a satisfactory bond to be made. In short, when the melting point of the inner metal substantially exceeds that of the outer metal, the process becomes increasingly difficult. Moving in the other direction increasingly facilitates it.

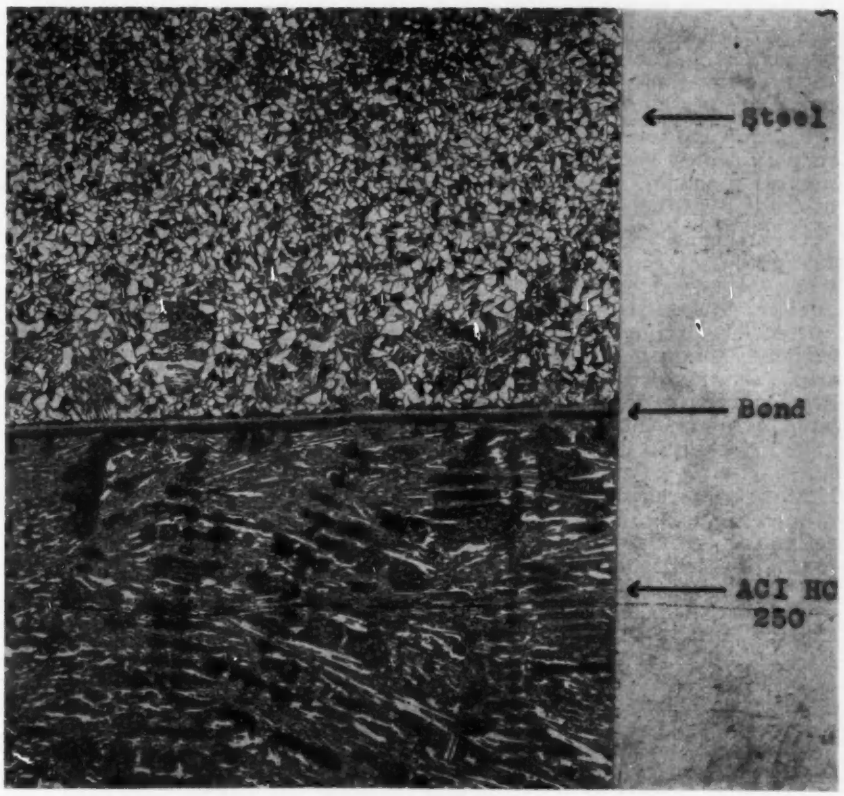


Fig. 9—Microstructure at and adjacent to the bond for the lift pipe shown in Fig. 8 (Etched—20 diameters)

Higher Octane Gas

E. V. Murphree, J. P. Haworth, and A. F. Kaulakis,
Standard Oil Development Company

A. R. Cunningham, Esso Standard Oil Company

Excerpts from paper "The Trend to High Octane Number Gasoline Is Sound" presented at SAE Metropolitan Section Meeting, New York, Oct. 15, 1953.

THE trend to high octane number gasoline is sound —both from the standpoint of the consumer and conservation of the nation's natural resources. Energy required by "new" refining processes to improve octane number will be more than offset by the increase in average car efficiency between 1951 and 1956.

The effect of adding the newer processes (catalytic cracking, thermal and catalytic reforming) to the prewar refinery is summarized in Table 1. Two points are pertinent:

1. Compared with prewar, the catalytic-cracking refinery of 1951 could supply a much higher octane number gasoline . . . and with a substantial saving in crude resources.

2. Further increases in octane number (to satisfy 1956 and 1961 estimated car populations) can be readily obtained by using reforming processes in addition to catalytic cracking.

Use of reforming processes to get higher octane gasoline, however, involves added crude consumption . . . and requires more energy to refine the crude. From a conservation of natural resources standpoint, this can only be justified if there is a net gain in energy utilization per barrel of crude refined. A study of energy balances shows that more efficient use of energy does result.

Energy balances for both catalytic cracking and reforming processes are given in Table 2. Energy input rose from 61.3 to 62.6 billion Btu per day (2.1%) when either thermal or catalytic reforming was added to increase octane number level above that obtained with catalytic cracking only. This reflects the increase in crude run from 10,000 bpd to 10,350 bpd.

The term "gasoline energy debit" includes the energy available as heat of combustion in the gasoline, plus all the energy expended in refining. As shown in Table 2, 0.7 to 0.8 billion Btu per day additional energy was consumed by refineries B and C in making the higher octane gasoline.

The work that can be done by the higher octane gasoline will, of course, be greater—provided automobile engines are designed to use it.

Table 3 shows the compression ratios that could completely utilize the quality of the gasolines produced by refineries A, B, and C. For the regular-

Table 1—Summary of Results Obtained with Past and Future Refineries

Refinery To Satisfy Cars in	Prewar —	A 1951	B 1956	C 1961
Research Octane No.[a]				
Regular Gasoline	82.0	88.0	91.6	93.7
Premium Gasoline	88.0	94.0	97.6	99.7
Crude Run, bpd	11,100	10,000	10,340	10,350
Gasoline, bpd	4590	4590	4590	4590
Middle Fuels, bpd	3260	3260	3260	3260
Bunker Fuel, bpd	3040	2040	2135	2120

[a] tel/gal—2.00 cc in regular, 2.75 cc in premium

Table 2—Energy Balance in Refining Crude

Refinery Reforming Step	A None[a]	B Thermal[a]	C Catalytic[a]
Raw Materials Input	61.3	62.6	62.6
Middle Distillate	18.9	18.9	18.9
Bunker Fuel	12.9	13.5	13.4
Gasoline	24.0	24.0	24.0
Refinery Fuel	5.5	6.2	6.3
Total Output	61.3	62.6	62.6
Gasoline Energy Debit	29.5	30.2	30.3

[a] Billion Btu/Day Gross Heat of Combustion

Is Sound

. . . More energy goes into making it,

but even more energy can be taken out—

if engines are built to take advantage of it.

grade gasoline, compression ratio could be increased from 7.0 to 8.1; for the premium gasoline, the increase could be from 8.2 to 10.5. Useful energy in each gallon of gasoline would increase from 43.1 ton-miles to 49.8, a gain of 15%. Now, from a fuels conservation standpoint, these figures should be compared with the gasoline energy debit. On this basis, too, energy utilization is higher, increasing from 281 to 317 ton-miles/mm Btu, a gain of 11%.

It should be emphasized that the calculations summarized in Table 3 are based on the assumption that:

1. Gasoline will be used in cars that are designed for the octane numbers listed.
2. Greater power available from the higher octane gasolines will be used to get more mileage; not to get better performance.

Actually, the energy utilization shown in Table 3 would not be fully realized until some years after the higher octane gasoline became available. That's because initially there would be a high proportion of older cars with lower compression ratios on the road.

However, even on the basis of the estimated population and compression-ratio distribution of cars on the road in 1956 and 1961, energy utilization would be better for the higher octane number fuels. Table 4 shows that ton-miles/gal would increase from 37.7 to 43.3, while ton-miles/mm Btu would increase from 246 to 276.

Thus, it is evident that the energy spent in thermal reforming to improve gasoline octane number will be more than offset by the increase in average car efficiency between 1951 and 1956. The anticipated increase in engine efficiency of the average car in 1961 should result in the most effective use of crude energy resources yet realized. What's more, as the compression ratio of the average car rises above that expected for 1961, even more efficient utilization should be realized. It should be possible to approach 317 ton-miles/mm Btu, as compared to a value of 246 for the average car in 1951. This gain of 25% represents a substantial saving in the consumption of our natural resources.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Table 3—Energy Utilization with Cars Designed for High Octane Fuel

Refinery Reforming Step	A None	B Thermal	C Catalytic
Research Octane No.			
Regular Gasoline	88.0	91.6	93.7
Premium Gasoline	94.0	97.6	99.7
Compression Ratio			
For Regular	7.0	7.6	8.1
For Premium	8.2	9.5	10.5
Ton-Miles/Gal[a]	43.1	47.0	49.8
Ton-Miles/Mm Btu[a]	281	300	317

[a] Assuming all cars just satisfied by gasoline produced

Table 4—Energy Utilization During Transition Period of Replacing Old Cars

Refinery Reforming Step	A None	B Thermal	C Catalytic
Car Population	1951	1956	1961
Ton-Miles/Gal[a]	37.7	40.9	43.3
Gasoline Energy Debit	29.5	30.2	30.3
Ton-Miles/Mm Btu[a]	246	261	276

[a] For average of all cars on road

Air-Spring Suspensions

. . . In Commercial Hauling Vehicles

C. O. Slemmons, General Tire & Rubber Co.

Based on paper "Air Spring Suspensions Get a New Lease on Life" presented at SAE Metropolitan Section Meeting, New York, Dec. 10, 1953.

AIR-SPRING suspensions are celebrating their 50th anniversary in a big way. They're getting their long-awaited chance to crack the steel spring's hold in commercial hauling vehicles . . . and their stock has never been higher. Why? Because fleet operators recently found that air-spring-equipped trailers have superior springing characteristics and vastly improved axle load distribution.

Probably the best way to tell the "air spring story" is to consider the construction and basic characteristics of one type of air spring—a 66-in. long, narrow one. Fig. 1 shows such a spring, together with the lower-beam compression chamber and the axle bushing assemblies.

How an Air Spring Is Put Together

This spring has two individual cells with interconnecting passageways. (See Fig. 2.) These cells are joined and bonded to upper and lower metal channels in a curing process. Construction of the cells is the same as that of a tire sidewall, except that the air envelope—whose counterpart is the tire inner tube—is an integral part of the structure. The Neoprene cover of the spring resists weather cracking, as well as contaminating agents such as petroleum products.

There are two $\frac{3}{8}$ in. passageways between the spring and the lower beam. These offer sufficient resistance to produce about one-half of the dampening necessary to quickly dampen out a sudden deflection of the spring. (One shock absorber on each side provides the additional dampening.)

Heavy rubber axle bushings are used in the journals which secure the axle to the lower-beam compression chamber. These bushings permit rotation of the axle with respect to the beam and resist the attempted steering of the axles as a result of trans-

Continued on Page 45

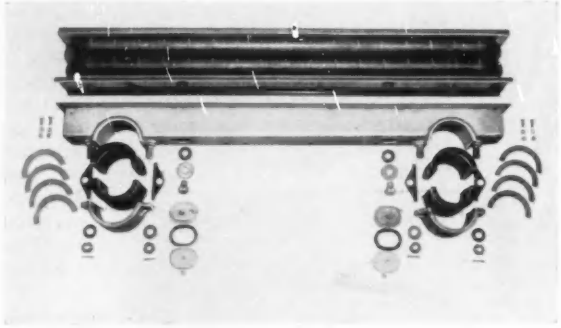


Fig. 1—Long, narrow air springs such as this have come through tests on highway trailers with flying colors

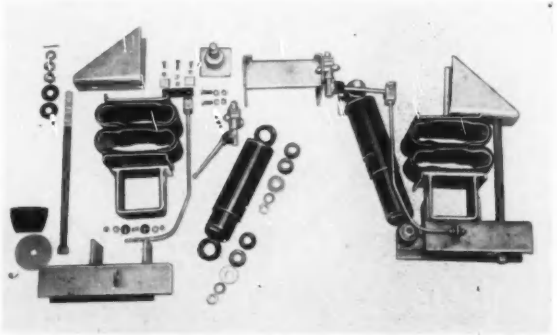


Fig. 2—Basic parts of an air-spring suspension are shown above. They include the spring itself, a height-control valve, a shock absorber, and a rebound bumper

Find Life Begins at 50

. . . In Buses

H. E. Fox and D. J. LaBelle, GMC Truck & Coach Division, GMC

Based on paper "Motor Coach Suspensions" presented at SAE National Transportation Meeting, Chicago, Nov. 2, 1953.

AIR springs have captured the suspension job in GM coaches. Steel springs just couldn't hold the fort any longer. They were overwhelmed by the air spring's superiority on all of these fronts:

- **Spring rate**—An air spring can be designed so that its spring rate increases with load. This ideal condition can't be achieved with simple leaf springs.
- **Platform height**—With air springs, platform height can be kept constant automatically in a very simple way. This is not true of steel springs.
- **Axle positioning**—With air springs, axle positioning is done by a system of torque rods and stay bars. With a leaf spring, on the other hand, this job must be performed by the spring itself . . . and the additional stiffness required reduces riding quality.
- **Friction,** which is responsible for the direct transmission of vibration from an axle to the body, is practically nil with air springs. The conventional leaf spring is particularly poor in this respect.
- **Noise level** is appreciably lower with air springs, all other things being equal.
- **Maintenance** is considerably reduced with air springs; life is longer.

Fig. 1 shows how the principal parts of the air suspension are applied to a bus. Air is contained in four air beams (two at each axle) which also carry body loads (vertical only) to the axle. Mounted below each air beam are two rubberized nylon cord bellows. These bellows serve as flexible connections between the frame and the axle. As the axle moves up and down the bellows flex, causing a change in volume with a resulting increase or decrease in air pressure. This constitutes the elastic medium which absorbs the shock of the bump.

"Brain" Keeps Platform Height Constant

Brain of the suspension system is the automatic height-control valve shown in Fig. 2. Mounted on the coach body frame, its operating lever is connected by a link to the axle. Its function is to maintain the correct riding clearance between body and axle. As passengers board the coach, the bellows compress and the body moves down toward the axle. As this happens, the connecting link moves the valve lever in the proper direction to admit more air to the system. The increased pressure returns the body to its original position. Conversely, as passengers leave the coach, the valve lever is moved in the opposite direction, exhausting air from the bellows, and returning the body to its original position with respect to the axles.

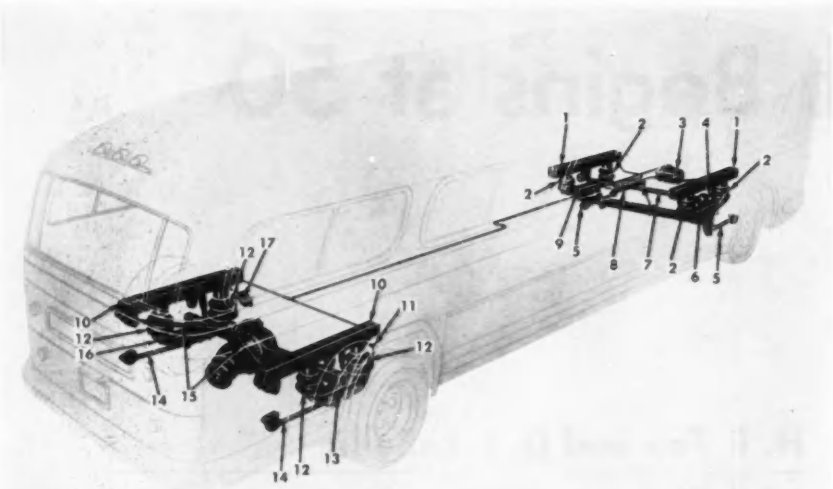
Thus the body is always maintained at a fixed-position with respect to the axles, regardless of load, and the deflection rate of the system is always directly proportional to the load. This results in constant frequency and the same soft ride regardless of whether the coach is loaded or empty.

A height-control valve never admits or exhausts air except when the load is changed. It pays no attention to normal movements of the axle which occur when the coach is moving over a rough road. This function is accomplished by a hydraulic damping device, so arranged that a valve does not operate except when the change in distance between axle and body is very slow and steady, such as occurs when loading and unloading.

Separate System for Axle Positioning

An important function of any suspension system is its ability to keep the axle properly positioned. Ideally the axle should be allowed to move only in a vertical plane with respect to the vehicle body. Any lateral or longitudinal movement, any twisting of the axle about its own axis, any turning out of the vertical plane is to be avoided. Any of these movements may have a serious effect on ride, tire wear, and, most important, steering geometry and vehicle control.

In a conventional leaf-spring suspension, part or all of the job of axle positioning is done by the



1 Front Suspension Air Beams
2 Front Suspension Air Bellows
3 Auxiliary Air Tank
4 Front Axle Upper Radius Rod
5 Front Axle Lower Radius Rods
6 Front Suspension Support (Right)
7 Front Axle Lateral Stay Rod
8 Front Suspension Height Control Valve
9 Front Suspension Support (Left)
10 Rear Suspension Air Beams
11 Rear Suspension Height Control Valve (Right)
12 Rear Suspension Air Bellows
13 Rear Suspension Support (Right)
14 Rear Axle Lower Radius Rods
15 Rear Axle Upper Radius Rods
16 Rear Suspension Support (Left)
17 Rear Suspension Height Control Valve (Left)

Fig. 1—This shows the principal parts of the air suspension system applied to GM coaches

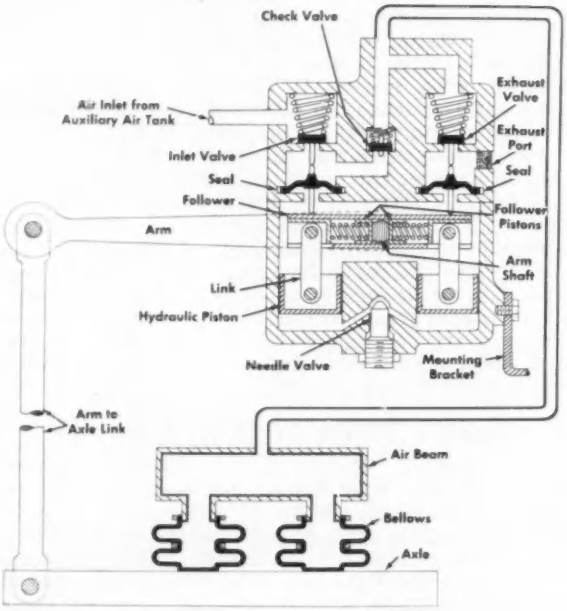


Fig. 2—Brains of the air suspension system is an automatic height-control valve

spring itself. This feature is quite appealing because of the economy of making the one member do several jobs. However, the spring designer is forced into the compromise of adding stiffness to the spring to keep stresses in a reasonable range, thereby sacrificing ride quality.

With an air suspension, however, all work of axle positioning is done by a system of torque rods and stay bars which minimize the movement of an axle with respect to the body except, of course, for vertical movement.

The torque rods and stay bars are equipped with rubber bushings at each end. These bushings absorb shock and road noises and eliminate the need for lubrication.

The rods are mounted in a fore-and-aft direction, above and below each axle. They absorb the longitudinal forces resulting from driving and braking, as well as horizontal components resulting from the tire striking bumps. Axle torque from driving and braking is also reacted by these rods. Lateral bars keep the body centered over the axle when the vehicle is rounding a curve or driving on a side slope.

This method of axle positioning results in a safety feature. Independent of bellows condition, the axle is always held in its geometrically correct position, thus assuring the driver of complete vehicle control.

Friction Is Practically Nil

In any suspension system it is important that friction be eliminated, since friction (particularly static friction) is responsible for the direct transmission of vibration from an axle to the body.

The conventional leaf spring is particularly poor

in this respect. Interleaf friction varies with degree of lubrication, condition of leaf surface, and clamping load. Also it is especially high for small axle movements. With friction so variable, it cannot be depended upon as a damping device in itself. And it makes design of shock absorbers, to provide accurate net control, very difficult.

In the air suspension, practically all friction is eliminated and shock absorbers can be designed to control only excessive axle movements such as occur on "thank-you-mam" bumps and washboard roads. This leaves the suspension practically free on normal road surfaces and provides the optimum in softness of ride.

Less Noise

Axle, wheel, brake and tire noises are transmitted to a vehicle body through the suspension system. Now, resistance to transmission of high frequency vibrations through air and rubber is much greater than through steel. An indication of this resistance can be shown by assuming the resistance coefficient of air is 1.0. A like coefficient for rubber would then be 0.002 and for steel 0.00001.

This does not mean that a steel spring suspension is 100,000 times or even 500 times as noisy as an air suspension. The only provable statement is that an air suspension is noticeably more quiet than a leaf-spring suspension in an otherwise similar vehicle.

Maintenance Down, Life Up

In these days of ever-rising costs, it becomes increasingly important that the designer of a new device pay particular attention to ease of maintenance and, if at all possible, elimination of maintenance.

With an air suspension, it has been possible to reduce maintenance considerably. Items:

1. Metal springs fatigue and wear, and thus have a definitely limited life. Air does not. The nylon cord bellows operate at very low flexural stresses, and tests to date indicate that life is much improved over leaf springs.
2. Because high frequency vibrations are reduced or eliminated, life of body and chassis structural parts should be greatly improved.
3. There are no metal-to-metal joints having relative motion. Therefore no lubrication or wear replacement is required.

The best way to evaluate an air suspension, however, is to compare its performance with that of a conventional leaf-spring system in similar vehicles. (See Fig. 3.) These curves are for a 51-passenger transit bus, heaviest vehicle for which the air suspension has been designed.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

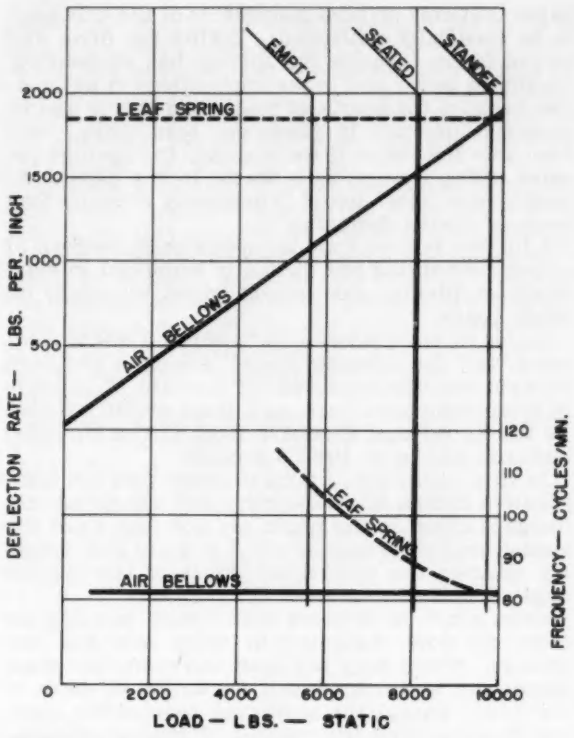


Fig. 3—This shows the suspension characteristics of an air-suspension-equipped 51-passenger transit bus as compared to a leaf-spring-equipped one

Excerpts from Discussion by . . .

N. E. Hendrickson,
Consulting Engineer

I agree with the authors that air is a most effective medium of suspension. There's plenty of it available, it costs nothing, and its elastic properties are constant in the temperature ranges we're likely to encounter in spring suspensions. Further, the new suspension is apparently well-designed to use these advantages.

On the other hand, I suspect that the cost of a suspension using air as the elastic medium will be much higher than that of a conventional steel spring suspension.

Actually, leaf springs on automotive vehicles have had a long and honorable career. And I personally hope they will be with us for many years to come.

Perhaps these new suspensions will spur the proponents of steel springing to eliminate its faults.

Among these, I consider excessive and variable friction between the leaves as the most serious. It is well known that all the load transfer from the longer to the shorter leaves occurs at the leaf ends, usually in a distance of 2 to 4 in. from the tips. In passenger-car springs, this friction problem has been effectively solved by inserting plastic or fabric liners or pads, impregnated with suitable waxy lubricants, at the ends of the leaves. These in turn are roll-tapered to make them flexible. It should be possible to develop similar pads or liners that would stand up to the heavier unit loads of the bus spring, particularly if the leaf ends are slim-tapered and flexible. The cost of such a refinement would not be very high, and it would allow us to retain the advantages of inherent damping without excessive breakaway friction.

Further, I cannot agree with the authors of the

paper that only *vertical* movements of the axle need to be elastically controlled. Taking the drive and torque forces through the springs has successfully cushioned power and brake applications in automotive vehicles for nearly 40 years, and this is almost universal practice in passenger cars today. Nor does this Hotchkiss drive through the springs require stiffer springs, as is stated in the paper. At least I have never found it necessary in many long years of spring designing.

I further believe that the sidewise deflections of a long rear spring are distinctly beneficial in elastically cushioning side impact forces, especially on rough roads.

As for variable rates in leaf springs, I might comment that the "shackle angle" principle has been very successfully employed for upwards of 15 years in many passenger cars, and some motor coaches. To my knowledge, excessive wear in the threaded bushings has never been a problem.

In this connection, I must mention that the comparative curves of steel-spring and air-spring deflections given in the paper are not fair, since the steel-spring curve is shown as a straight line, ignoring entirely the progressive effect of the shackle angle.

Once again, as in years past, I want to plead for more generous designing in truck and bus leaf springs. When they are long and wide, the main leaves can be thick enough for ample strength in the eyes. This at the same time reduces the number of leaves, and the number of friction surfaces. Thus the longer a spring is, the more efficient it becomes, for the clamped distance at the axle is a smaller proportion of the total length. Using fine alloy steel, properly heat-treated, allows higher stresses and saves weight. I have found that the most expensive spring steel, chrome vanadium, makes the cheapest spring in terms of maximum flexibility and lowest cost per mile.

A. S. Krotz,
B. F. Goodrich Co.

In commenting on this excellent paper, we wish in no way to detract from the major accomplishments reported. We wish only to offer some thoughts which may represent at least a change in emphasis due to our different approach.

The ability to valve air into this spring to maintain constant level is a spectacular and easily demonstrated advantage. To some extent this hides the also important function of automatically replacing any air lost out of the system.

The problem of locating the wheels or axle by means of radius rods is a serious one. It involves some compromises. However, with a constant-level device that assures the vehicle will always operate in the same position, it is probably practical to accept some errors in geometry which could not be tolerated using more conventional systems. In any event, we do not believe that too great a degree of rigidity is desirable in locating the wheels. There are instances, such as the German Mercedes, where a designer has purposely put some elasticity in his linkage, undoubtedly to avoid harshness and to provide a low noise level. In the design in question, the same effect is obtained by the rubber bushings in the radius rods.

Since a constant-level device holds a vehicle at a predetermined level regardless of load, the advantages of using a variable-rate spring system must be found in riding comfort and ability to prevent "strike through."

Considering the advantages of variable spring rate as a means of avoiding strike through, the benefits of the variable system will be considerably less where constant level is maintained. Every suspension system incorporating a bumper can be thought of as a variable system. If the bumper is very shallow and stiff it may limit axle travel but only by exerting high force and consequently high stresses on the parts involved. It is not sufficient to talk about 3 G or 8 G or any other measure which is concerned only with the end forces where the motion of the axle is finally stopped. The function of stopping the motion between the axle and body is a kinetic function and should be studied by area under a load-deflection curve. The variable rate suspension will undoubtedly give greater area than any other system for equivalent stresses at the end of the axle motion and anything approaching the same rate. However, with a constant-level device and an adequate bumper the difference between constant and variable spring rate becomes relatively small.

The question of roll stability has undoubtedly received considerable attention from the designers of this air system. With the legal limits on vehicle width now enforced in many states, the space available between dual rear wheels and front wheels is limited. Assuming a total of 46 in. at the rear and 38 in. between possible leaf-spring centers, the air spring (which is wider than the leaf spring) will probably necessitate sacrificing some of the width formerly obtained with leaf springs.

Since roll resistance for a given spring rate will vary as the square of the transverse spring spacing, it seems probable that air springs will sacrifice some of the roll resistance obtained with some other types of suspension. While the constant-level device can be used to aid in correcting any objectionable roll, it is obvious that the leveling device cannot function until the bus has started to roll, thereby operating the leveling valve. There is some question whether the feeling of satisfactory control and stability could be maintained if the vehicle is permitted to roll even slightly at a very soft rate before correction takes place.

It seems obvious to us that there will still be many places where leaf springs, coil springs, and torsion bars will continue to be used most advantageously. However, we feel we are now approaching an era where the unlimited capacity of air, if it can be properly trapped and controlled, and the greatly increased capacity of rubber to momentarily store energy, will cause an increased number of engineers to discard steel in favor of one of these more advanced means of suspension.

Author's Closure to Discussion

We agree with Mr. Hendrickson that the initial cost of an air suspension, in its present stage, does exceed that of steel springs. We believe, however, that over a 10 to 15 year period the total cost, including both initial cost and maintenance expense, will be less for the air suspension.

We cannot agree that Hotchkiss drive through springs has been entirely successful, nor can it al-

ways be obtained without additional spring rate. In a front-axle-drive truck, we found that eliminating Hotchkiss by using torque rods and shackling the spring at both ends, we improved riding, braking, and steering. At the same time, we decreased the weight of the spring by 40% while increasing front-axle load 30%.

We would like to correct one point mentioned by Mr. Krotz in connection with the leveling valve. Perhaps the word "leveling" is misunderstood. It is not an anti-roll device. The time required for its action (3 to 5 sec) is entirely too long to correct any rolling tendency on all but the longest curves.

We depend not only upon the transversed positioning of the air bellows, but also upon the resistance to torsional deflection of the torque rod bushings to prevent roll. Furthermore, the lateral radius rods, as used in the air suspension, permit raising the roll center and tend to compensate for the somewhat narrower spring centers.

Again in connection with the leveling valve, the air suspension system could be made as airtight as a tire. The possibility of leakage did not dictate use of the leveling valve in the original design.

With regard to axle positioning, it has been our experience both in the development of the air suspension, as well as on 6-wheel trucks with conventional leaf springs, that torque-rod positioning of axles does not compromise geometry. It is possible to incorporate any degree of flexibility in the torque-rod bushings, but our experience to date indicates they should be relatively rigid.

As to variable rate, if there was ample room for axle travel, variable rate would have less value. This is not the case even with the leveling feature, and we have found variable rate a definite advantage. In addition, variable rate helps to minimize the change in height with temperature change. This change is only 1 in. for a 50 F temperature change. This height change can only occur, of course, with the vehicle parked, with no air in the supply tanks.

Before the air suspension was used, variable frequency was a noticeably objectionable feature. The change in sprung weight on our 41-passenger intercity coach is about 55% and on a 51-passenger transit coach about 85%. This represents about 25% change in frequency for intercity and 36% for transit. This amount of change makes a very noticeable difference in ride.

In Commercial Hauling Vehicles . . . continued from page 40

verse loads. They also permit one axle to be in a different plane than the other axle. In other words, they serve a function of flexible restraint.

Fig. 2 also shows three other important air-spring suspension components—height-control valve, shock absorber, and rebound bumper.

The principal components of each height-control valve (each spring has one) are five zinc-base die castings, a sintered metal gear, and two rubber-faced valve discs. The air supply is brought to the valves through a safety valve which prevents flow of air below 60 psig from the brake system to the air-spring suspension system. Before the air reaches the height-control valves, it passes through a small filter.

The control arm on each valve is connected to an operating link by a rubber-covered fabric strap. This strap permits very free swiveling and twisting movement through the full range of the valve (4 in. up and 4 in. down from the neutral position).

The height-control valves are generally located back-to-back, and as high above the road as possible. The latter helps to keep them from being splashed.

Two shock absorbers mounted in sea-leg fashion at the center of the tandem add resistance to the net movement of the axles. They do not affect equalization.

Rebound bumpers placed outside of the springs restrain body roll.

This 66-in. air spring will support appreciable load in compression only. Therefore, the braking torque, braking thrust, and laterally applied loads (brought about by changes in vehicle direction) must be taken through control arms or guides. In addition, control of body sway may require a sway bar or some device to limit the separation of an axle from the frame. There are several ways in which these forces may be transmitted from the axles to the frame or body.

What an Air Spring Offers

Now, having seen how an air-spring suspension is put together, let's see what it has to offer in the commercial hauling vehicle field.

With air springs, it is possible to get a low spring rate for a lightly loaded vehicle and a high spring rate for the same vehicle when heavily loaded. This inherent feature of an air spring nicely accommodates the requirements of empty tankers where a low spring rate is needed to prevent destructive impacts and vibration.

Reduced impact on the tires can result in large savings inasmuch as tire costs represent a large proportion of vehicle maintenance. The great reduction of high-frequency vibrations means a considerable savings in the upkeep of the body or tank. Load is distributed over a length of 66 in. on the frame, which is a considerable improvement over the usual one, two, or three points of attachment. This suspension will also yield in the fore and aft direction, thus absorbing impacts that would otherwise be passed on to the tank.

The family of curves in Fig. 3 shows the change in deflection with load for a 66-in. trailer spring. The sharp increase in spring rate is partially due to bottoming bumpers which come into action when the spring is deflected 1½ in. These bumpers are at the center of the spring. They do not affect the

articulation. There are lower bumpers at the ends of the spring which prevent damage to the spring ends under extreme articulation.

Note that the spring rate (slope of line drawn tangent to the 41.8 psig curve at 6 in. height), which is applied to two wheels, is 4500 lb at the design height of 6 in. Most leaf-spring installations are more than double this figure, or 5000 lb per wheel. Thus, even when a vehicle is fully loaded, the air spring has a great spring rate advantage over conventional springing.

The load-deflection curves of air springs can be adjusted to suit specific requirements by changing the volume of the compression chamber. Further adjustment can be realized by changing the size of the spring.

In contrast to a steel spring, when a spring rate is selected no consideration need be given to the difference in carrying height between an empty and loaded vehicle. This is taken care of by fully automatic height-control valves which simply call for air until the load is carried at the normal spring height.

Fig. 4 shows how 66-in. air springs would look installed. As shown in the illustration, the pivot for equalization of load between the axles floats. It has practically no frictional resistance. Equalization of load between the axles is perfect as long as the beam is parallel to the frame. Due to the fact that the effective area of the spring increases as the height is reduced, one end of the spring, hence one axle, will carry more load than the other with an appreciable amount of articulation. However, this load transfer characteristic is not appreciably different dynamically than it is statically. Actually, we know of no other equalizer that approaches the dynamic efficiency of load distribution obtained with an air spring.

The automatic height-control feature of air springs keeps a vehicle body parallel to the axles at all times except, of course, when the spring is loaded dynamically. A high crowned road or an improperly placed cargo will not cause the vehicle to lay over. Also, the height of the trailer bed will remain constant for convenience at the unloading dock.

Now, one of the most important yardsticks in evaluating any suspension is the length of service that can be obtained without attention to, or replacement of, parts. We have not yet measured the full life of any air spring. However, the two-cell construction that has been discussed has been in existence for two years . . . and the longest tallied mileage is 225,000.

While on this subject, it should be mentioned that use of rubber bushings at all moving joints eliminates the need for lubrication.

Truckers Enthused

Approximately 100 vehicles are equipped with these air springs, some of which are in every representative area in the country. Truckers have been very enthusiastic about adapting this type of springing to their equipment.

As expected, there has been some difficulty in sealing and preventing leakage at the various connections. But this situation is improving rapidly with the training of assembly personnel and those who service vehicles preparatory to delivery to customers. Difficulties experienced have been attributed mainly to improper installation of the air system.

Now that we have developed a practical application of the air spring to trailer units, there is considerable customer demand for doing the same thing with trucks and truck-tractors.

We believe that the solution of this problem is one which should be worked out by individual truck manufacturers. They can draw upon our experience and incorporate the basic spring components in their vehicles, each in their own way.

Certainly by materially reducing the spring rate, truck manufacturers can take a big step forward in providing more driver comfort . . . and longer, trouble-free truck service.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

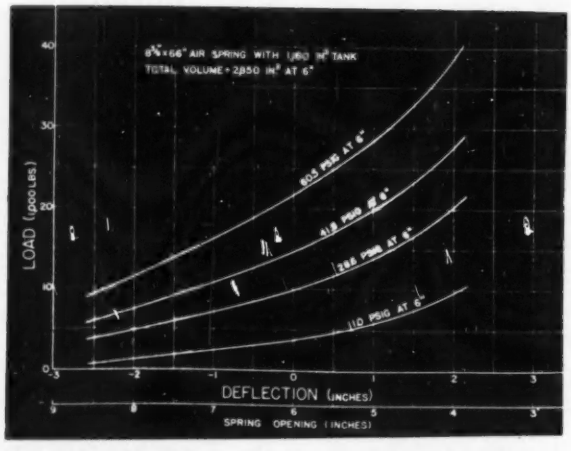


Fig. 3—With air springs, it is possible to get a low spring rate for an empty vehicle and a high spring rate for the same vehicle heavily loaded

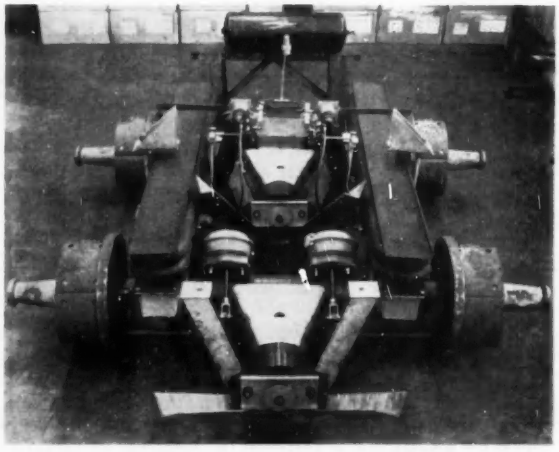


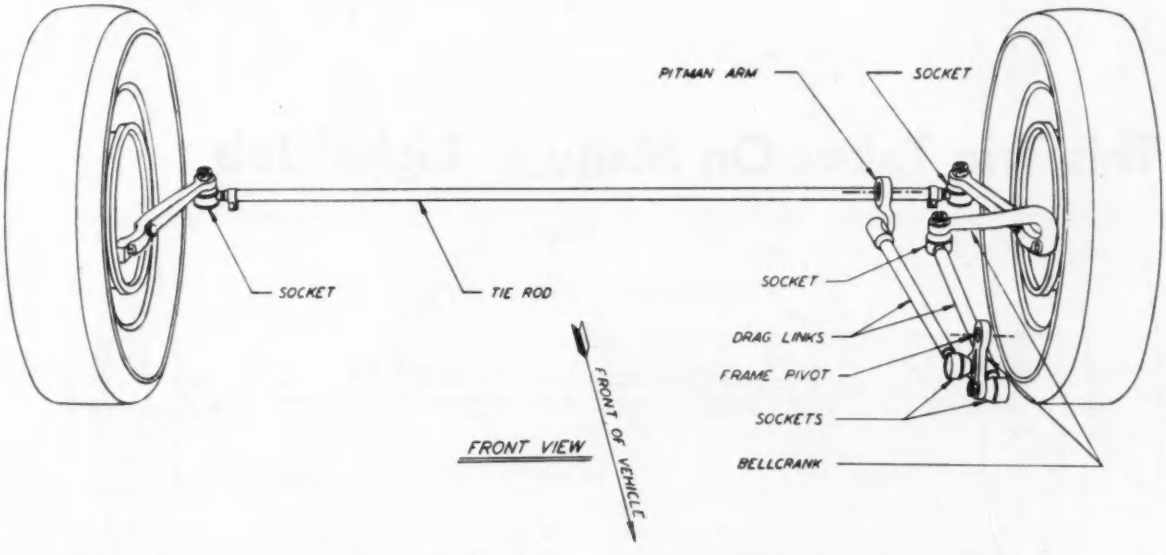
Fig. 4—This shows how 66-in. air springs would look installed

Six Steering Linkages Get Most Truck and Bus Jobs

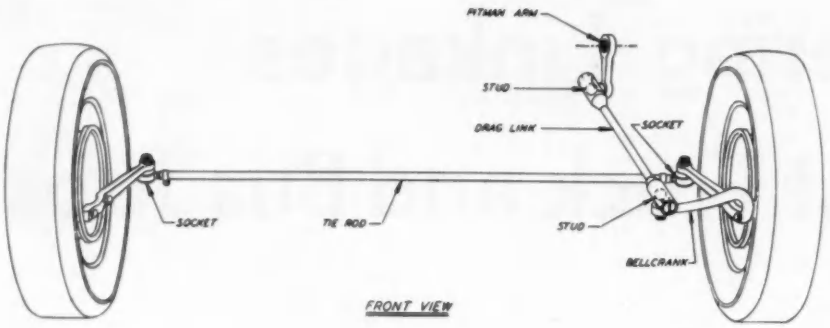
James H. Booth, Thompson Products, Inc.

Based on paper "Steering Arrangements and Ball Suspension Possibilities for Commercial Vehicles" presented at SAE National Transportation Meeting, Chicago, Nov. 2, 1953. (Complete paper is available in full in multilithographed form from Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

These Three Handle the "Heavies"

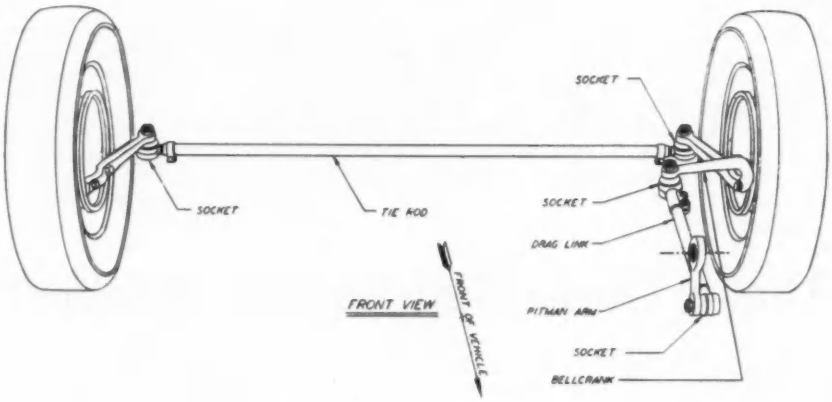


1 SOME HEAVY COMMERCIAL VEHICLES use this fore-aft and cross-steer linkage which has an intermediate bellcrank. In this arrangement, two fore-and-aft drag links connect the pitman arm to the steering arm and the frame-mounted bellcrank. Drag-link lengths are adjustable so that the steering wheel can be properly centered. (This helps to insure long steering-gear life.) Wheel toe-in is provided by an adjustment in the cross tie rod. Please turn page

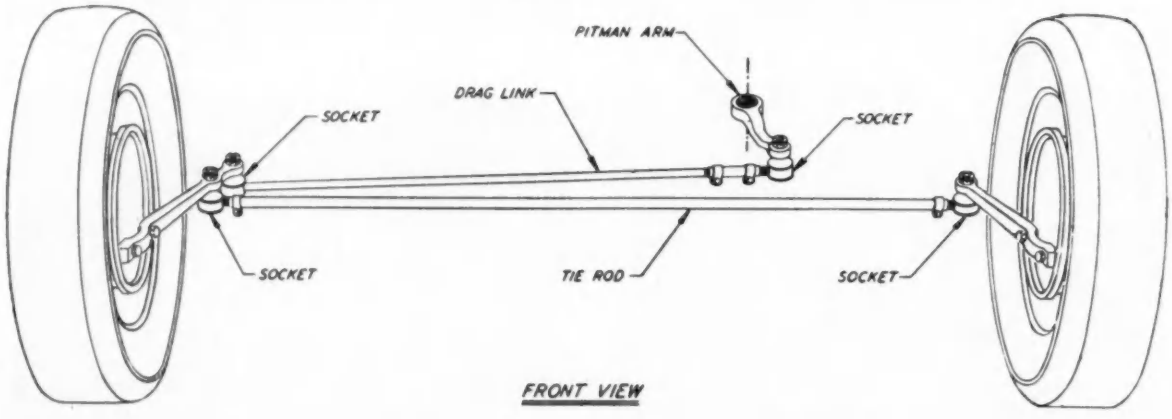


2 OTHERS get a linkage that has horizontal sockets on the single fore-and-aft drag link . . . and vertical sockets on the cross tie rod.

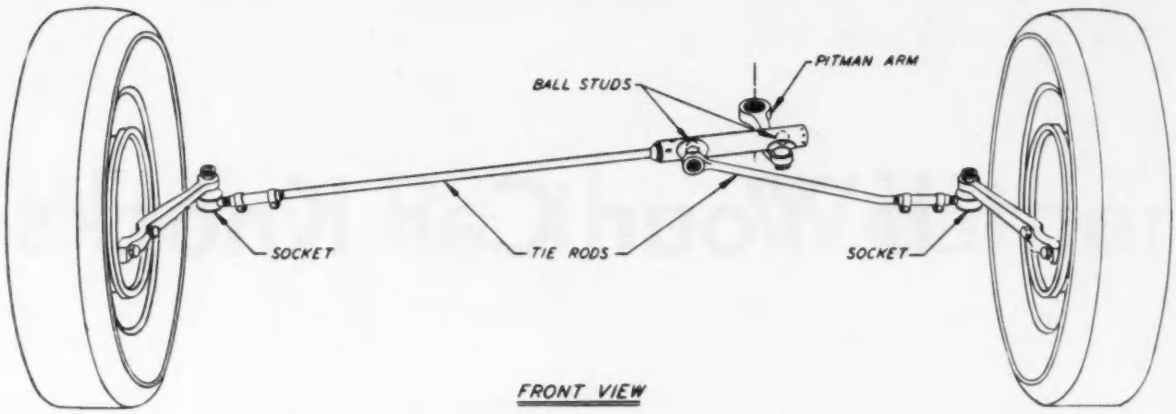
3 BUSES often are equipped with a steering gear that is mounted ahead of the axle. The adjustable fore-and-aft drag link in this system must be short.



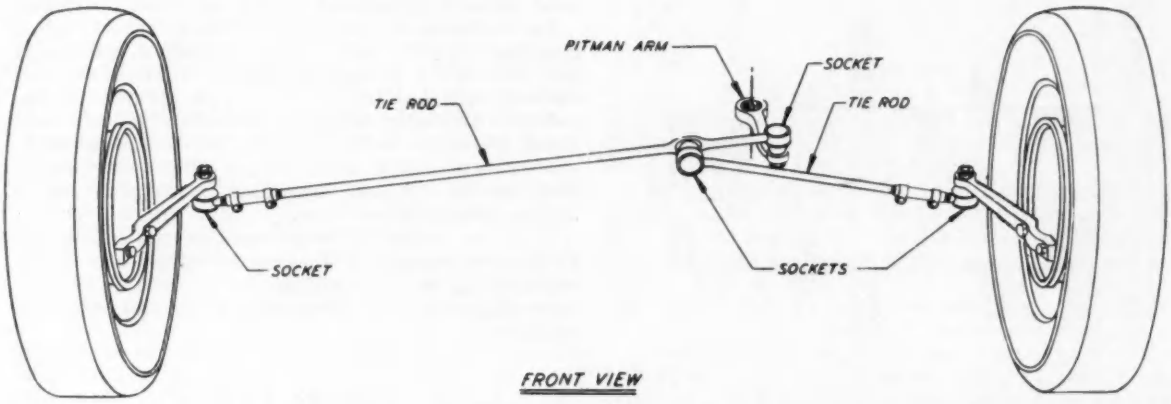
This Trio Takes On Many a "Light" Job



4 SMALLER COMMERCIAL VEHICLES, such as light delivery trucks, frequently use this type of cross steering linkage. Note that the pitman arm is connected by a cross drag link to the steering arm of the wheel on the opposite side of the vehicle. Sockets are generally of the vertical type.



5 HALTENBERGER LINKAGE is also used on light commercial vehicles. A tube on the end of the long tie rod provides a horizontal socket. This socket holds the pitman-arm ball stud as well as the stud at the inner end of the short link. It also contains two springs which provide impact dampening.



6 ALL FOUR SOCKETS ARE VERTICAL in another type of Haltenberger linkage. As in the tubular-type Haltenberger linkage shown previously, turnbuckles provide adjustment at points adjacent to the steering-arm sockets.

Excerpts from Discussion by

W. K. Creson,
Ross Gear & Tool Co.

MR. Booth has had the chassis designer's usual difficulty in divorcing steering linkages from wheel supensions. He could have gone further and tied in tires, frames, shock absorbers, shackles and springs, and their effect on directional stability.

Whatever wheel suspension is used, independent or conventional, it is desirable that the steering linkage articulate at the centers of wheel oscillation, to avoid self-steering under conditions of jounce and body roll. If there is relative axle movement under brake application, it is desirable that the knuckle ball be located in the most advantageous position possible.

Empirical methods of anticipating the best location of pitman and knuckle armballs were worked out years ago; also instrumentation for verifying these locations on the pilot vehicle.

The instruments can be, and have been, adapted to various independent suspensions. The problem is always the same in principle:

- Avoid steering-wheel fight and creation of heavy forces to be blocked and absorbed by the steering gear and other chassis components.
- Avoid self-steering from jounce, body roll, and brake applications.
- Make the best possible compromise with units that must be used for reasons of economy and availability. A vehicle with perfect steering geometry is a rare jewel, indeed.

In recent years, means have been worked out for measuring drag-link forces under actual operating conditions. Such a determination, when combined with experience, is the acid test.

If Your Car Knocks

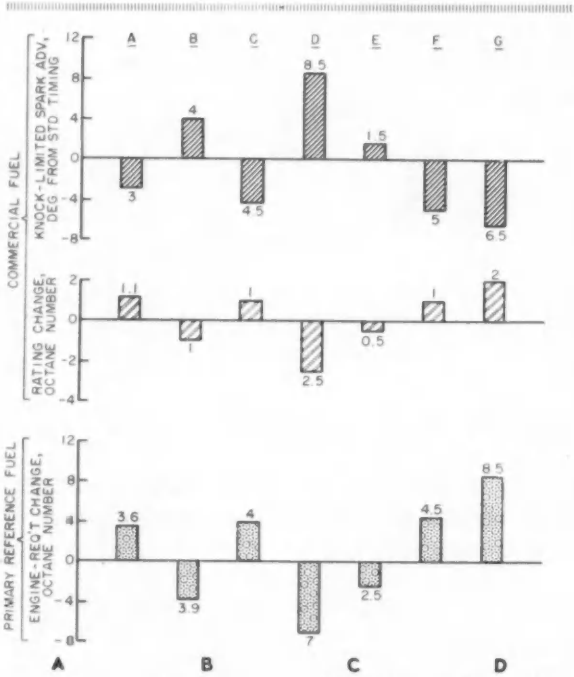


Fig. 1—Average effect of atmospheric and engine variables on fuel knock

ANTIKNOCK requirements of vehicles vary over a wide range as a result of seasonal variations in weather and associated engine and fuel variables.

For instance, an engine requires a fuel of higher antiknock quality when the atmosphere is dry and hot, and when high-temperature thermostats and water-glycol antifreezes are used. Minimum requirements occur when the weather is cool and moist, water is used as a coolant, and a low-temperature thermostat is used. Actual effects vary widely from car to car, but they may be as great as 15 octane numbers.

These are some of the conclusions reached during an Ethyl-Standard of Ohio cooperative study of the relationship between weather and knock. The data were obtained under both laboratory and field test conditions.

Variables Studied

The factors investigated during this program were:

1. Climatic conditions:
   a. Ambient air temperature.
   b. Humidity.
   c. Barometric pressure.
   d. Wind velocity.
2. Engine cooling:
   a. Thermostat operating temperature.
   b. Coolant type.
3. Fuel properties:
   a. Reid vapor pressure.
   b. Composition.

Under climatic conditions, air temperature, pressure, and humidity are of primary importance, while wind velocity, which has a bearing on engine temperature, is of lesser importance.

Many people use high-temperature thermostats to improve car heater performance or to raise the general level of engine temperatures. For this reason, it seemed desirable to find out how this practice affects knock requirements.

The use of permanent antifreezes of the glycol type is common, particularly in the more expensive,

It May Be the Weather

R. I. Potter and E. H. Scott, Standard Oil Co. (Ohio)
H. J. Gibson and G. W. Stanke, Ethyl Corp.

Based on paper, "Weather or Knock—Road Ratings and Requirement, Year-Round," presented at the SAE National Fuels & Lubricants Meeting, Chicago, Nov. 6, 1953. This paper will be published in full in the 1954 SAE Transactions.

high-requirement cars. The heat-transfer characteristics of these coolants are known to raise metal surface temperatures relative to those obtained with water. The combination of a high-temperature thermostat and glycol coolant would be expected to result in high engine temperatures.

To make the data of practical value, it was necessary to relate the findings in terms of commercial gasolines as well as the usual primary reference fuels. A wide variety of commercial gasolines, both premium and regular, and a number of special fuels were used in the tests.

Results

The average effect of most of the variables investigated is summarized in Fig. 1. In studying this chart, it should be noted that the averages tend to mask the large effects observed in some car makes. For this reason, these results do not necessarily represent the effects to be observed on any particular fuel-car combination.

The effect of variations in Reid vapor pressure are not shown in Fig. 1. That's because, within the limits of reproducibility, the chassis dynamometer results did not indicate any loss in vehicle octane-number rating with a fuel of 12-psi Reid vapor pressure over a fuel of 9-psi Rvp for the engine and climatic conditions studied.

The effect of fuel composition is not shown because the data obtained to date are far from adequate to permit drawing conclusions. They do indicate, however, that fuel composition changes do offer a fertile field for investigation. There is every reason to believe that fuels can be produced that will exhibit minmum change in road antiknock satisfaction with changes in atmospheric and cooling system variables.

The question may be raised as to what is the actual significance of this work to the automotive, petroleum, and chemical industries.

The automotive industry, in the past, has occasionally been criticized for building cars that exhibit a wide spread in octane-number requirements even when new. In one of the makes used in this study, weather and associated variables changed the requirement by 15 octane numbers. This might well indicate that some of the wide variations in requirement reported in the past among cars of the same make and model were due to variations in test conditions rather than among the cars themselves.

To the petroleum industry, this study indicates that weather and its associated variables are significant factors in fuel rating reproducibility, and in the ability of fuels to satisfy customer cars. It also indicates that the study of fuel composition offers a fertile field for investigation in the tailoring of fuels that will exhibit the minimum change in road antiknock value with changes in atmospheric and cooling system variables.

The chemical industry should be encouraged in the development of improved permanent antifreezes. This investigation indicated that in some cars there was an increase in engine requirement of several octane numbers accompanying the change from water to glycol antifreeze. This suggests an opportunity for progress in the development of antifreezes with improved heat-transfer characteristics. Until this can be achieved, the practice of draining permanent antifreeze as soon as there is no longer any likelihood of freezing weather should be encouraged.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Ingredients Can Make Oil A Stingy

MOST contributions are welcome, but this is anything but true of the donations lubricants made to combustion-chamber deposits. Fortunately, a way has recently been found to reduce the size of this "gift." The secret is to use as the base oil a low molecular weight distillate of controlled volatility.

Just why this should be done was revealed by a recent field study of the effect of the following lubricant variables on combustion-chamber deposit formation:

- Presence of residual materials (bright stock)
- Neutral distillate volatility
- Base stock type
- Polymeric thickening agent type
- Detergent-inhibitor type and concentration
- Oil oxidation
- Use of combustion catalysts in the lubricant

Now, in actual practice, deposits come from both the fuel and the lubricant used in an engine. Therefore, to make our study possible, we had to eliminate all fuel contribution to deposits. This was done by using the clean-burning, non-contributing fuel—isooctane.

This program was carried out using sixteen 1951 cars equipped with overhead valve, V-type engines of 7.5:1 compression ratio. After cleaning the combustion chambers, these cars were operated caravan-style on the test fuels and lubricants under controlled low-speed urban and suburban driving conditions.

Octane requirements were measured by the Standard Uniontown Procedure. The results are reported as equilibrium octane requirements after deposit buildup, rather than octane requirement increase. That's because the equilibrium requirement data are more reproducible and also represent what the average driver sees. Each fuel-lubricant combination was run in two cars. The repeatability of single determinations using 2 cars (2-car average) is believed to be in the order of ±2 octane numbers.

Table 1—Effect of Bright Stock on Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

% Bright Stock in Solvent Extracted Mid-Cont. Distillate	Equilibrium Octane Requirement[a]	Deposits	
		Weight g	Volume cc
0	84	11.4	6.9
8	90	27.0	22.5

[a] Average initial requirement 78

Table 2—Effect of Lubricant Volatility on Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

Solvent Extracted Distillate	Viscosity at 100 F SUS	Equilibrium Octane Requirement[a]	Deposits	
			Weight g	Volume cc
Wide Cut	165	84	11.4	6.9
Narrow Cut[b]	65	76	4.8	3.7

[a] Average initial requirement 78
[b] Contained V.I. Improver M as thickening agent to give 48.8 SUS at 210 F versus 44 SUS for wide cut distillate

Bright Stock Is Particularly Harmful

The highest molecular weight and least volatile component of a lubricating oil base is bright stock.

The effect of this type of material on combustion-chamber deposits was determined using a blend made by adding 8% of a solvent extracted, deas-

Donator to Deposits

J. G. McNab, L. E. Moody, and N. V. Hakala, Esso Laboratories

Excerpts from paper "The Effect of Lubricant Composition on Combustion Chamber Deposits" presented at SAE Annual Meeting, Detroit, Jan. 14, 1954. Complete paper will be published in 1954 SAE Transactions.

phalted, dewaxed, Mid-Continent residuum of 165 SUS viscosity at 210 F., to a distillate having a viscosity of 44 SUS at 210 F. The distillate used was also solvent extracted and dewaxed and came from a Mid-Continent crude source. The viscosity of the resulting blend was about 48 SUS at 210 F. Both the blend and the distillate were evaluated in the controlled field test cars using isooctane as fuel.

The lubricant blend containing the bright stock gave much larger amounts of combustion-chamber deposits and a 6 unit higher octane-number requirement than was obtained with the straight distillate. (See Table 1.)

These data indicate quite clearly that to produce a non-contributing lubricant, heavy components should be eliminated from the base oil.

Distillate Volatility Is Important, Too

Another important factor was considered to be the presence of heavy components in the neutral distillates used in the lubricant blend. Thus, the effect of eliminating them was investigated.

For this purpose, a narrow cut, lower boiling distillate was prepared from the same refinery streams used to produce the base case distillate. The viscosity of the narrow boiling distillate was 65 SUS at 100 F compared to 165 SUS for the base case distillate. To provide adequate viscosity (to avoid excessive oil consumption), the lower viscosity distillate was thickened with a viscosity-index-improving olefin polymer (V.I. Improver M) to a viscosity of 48.8 SUS at 210 F. This compares to about 44 SUS at 210 F for the base case wide cut distillate. These oils were then evaluated in two cars each using isooctane fuel in the controlled field test.

The narrow cut product gave no increase in octane requirement after 6000 miles, with an equilibrium octane requirement of 76. This compared to an octane requirement of 84 obtained with the base case wide cut oil, as shown in Table 2. This difference in requirement is attributed to the removal of the heavy ends in the lower boiling lubricating oil base stock. This removal of heavy ends is also reflected in the lower amount of combustion-chamber deposits found with the narrow cut oil. (See Table 2.)

These octane requirement data are compared with the previous data on the effect of bright stock in Fig. 1. The adverse effect of high molecular weight materials is quite conclusively shown in this figure.

Thus, the first step in preparing a lubricant which

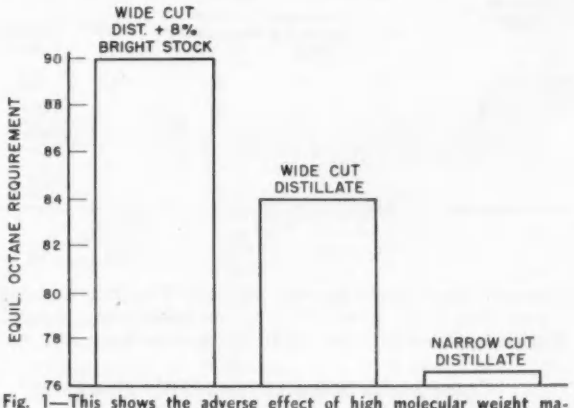


Fig. 1—This shows the adverse effect of high molecular weight materials (bright stock) on octane requirement

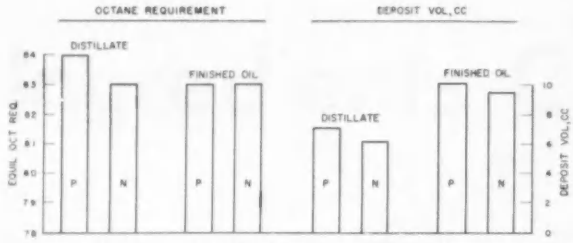


Fig. 2—Crude source has little effect on octane requirement and deposits (The "P" bars represent a paraffinic base oil, the "N" bars a naphthenic one)

Table 3—Effect of Crude Type on Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

Solvent Extracted Distillates	V.I.	Viscosity at 210 F SUS	Equilibrium Octane Requirement[a]	Deposits Weight g	Deposits Volume cc
Paraffinic	112	44	84	11.4	6.9
Naphthenic	40	55	83	7.3	6.2

[a] Average initial requirement 78

Table 4—Viscosity Data for Two Distillates

	Paraffinic Distillate	Naphthenic Distillate
Viscosity SUS		
100 F	165	513
210 F	44	55
Viscosity Index	112	40
% Paraffin Chains	69	48
% Naphthene Rings	27	42
% Aromatic Rings	4	10

Table 5—Effect of Crude Type on Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

Lubricant Type[a]	Base Stock Inspections V.I.	Base Stock Inspections Viscosity at 210 F SUS	Equilibrium Octane Requirement[b]	Deposits Weight g	Deposits Volume cc
Paraffinic	105	36	83	16.1	9.8
Naphthenic	40	40	83	17.6	9.2

[a] Contains V.I. Improver M and 5% detergent-inhibitor
[b] Average initial requirement about 78

does not contribute to combustion-chamber deposit formation is to start with a low molecular weight distillate of controlled volatility as the base oil.

Crude Source Seems to Have Little Effect

It has been claimed frequently over the years that naphthenic oils have less tendency to give combustion-chamber deposits than paraffinic oils. However, based on data obtained in this study, there does not appear to be a significant difference between paraffinic and naphthenic oils of the same volatility characteristics. The crude source and variations in the predominating types of hydrocarbon components in lubricating oil distillates appear to be relatively unimportant, compared to base stock volatility.

For example, an acid-treated naphthenic oil from Coastal crude was compared with the wide cut, solvent extracted paraffinic oil from Mid-Continent crude previously discussed. The two oils were very similar in volatility characteristics.

The cars operated on these two distillate oils and isooctane fuel came to very nearly the same equilibrium octane requirement of 83–84. (See Table 3.)

Some pertinent data on these two distillates are given in Table 4. It will be noted that the two oils had quite different viscosity characteristics. While the naphthenic oil was much more viscous, it was specifically chosen because it closely matched the volatility of the paraffinic distillate. There is a significant difference in the makeup of the oils from the standpoint of basic hydrocarbon types (ratios of paraffins to naphthenes to aromatics). If a major effect of crude type existed, it should have been observed in the preceding tests with these oils.

No effect of base stock type was observed in other studies with two finished low-viscosity motor oils. One oil was based on a paraffinic distillate, the other on a naphthenic distillate. These distillates were of lower viscosity than those used in the experiments described above. Both oils contained V.I. Improver M and 5% of a commercial detergent-inhibitor additive.

As shown in Table 5, no effect for crude source was noted, either in the octane requirement levels reached or the amounts of deposits formed.

These data are compared with the previous data for the distillates in Fig. 2. It will be noted that more deposits were formed with the finished lubricants containing the detergent additives. However, for some unexplained reason, this did not seem to adversely affect the equilibrium octane requirement.

These data on the absence of effect of crude type are in agreement with data reported recently by Ethyl which showed that crude type was not as important as lubricant molecular weight or volatility in determining the extent of combustion-chamber deposit formation.

A Lot Depends on V.I. Improver Used

These tests established that it is possible to make non-contributing base stocks from narrow cut, low viscosity neutral distillates. Next step is to produce a non-contributing finished lubricant. This involves finding suitable additives which provide the other necessary properties in the oil, but which do not themselves cause serious octane requirement increase.

The problem of providing adequate viscosity has been easily resolved. Since bright stock and higher molecular weight fractions of distillates are major contributors, they are eliminated, and thickening is accomplished by polymeric materials.

Careful selection of the thickening agent used is

necessary, however, since not all types of products used for thickening appear to be satisfactory.

The effect of adding a commonly used polyolefin thickening agent, V.I. Improver M, to a narrow cut, solvent extracted Mid-Continent distillate is shown in Table 6. Because of its chemical structure, this material would be expected to decompose on combustion and leave no carbonaceous residue. Past studies on certain special industrial lubricants containing this additive had, in fact, indicated this to be the case. It will be noted that the mineral oil blend of this material gave the same or lower equilibrium octane requirement as was obtained with the non-contributing synthetic oil Y. This indicates that V.I. Improver M does not contribute to deposits.

Not all V.I. improvers are necessarily free of combustion-chamber deposit-forming tendencies. For example, laboratory engine test results on a commercial V.I. Improver P, of quite different chemical composition than V.I. Improver M, indicate that it does contribute to deposits and to octane requirement increase. Blends of this V.I. Improver P in the low viscosity distillate would be expected to give about a 7 unit higher octane requirement in the field than was found with the V.I. Improver M blend.

It is believed that the physical nature of the deposits obtained with the oil blend containing V.I. Improver P may be responsible for higher octane requirement observed. These deposits appeared to form an adherent continuous film on the inside of the combustion chamber; the deposits from the blend with V.I. Improver M were granular in nature and more readily removable. Continuous films lead to high octane requirements, largely because of their good thermal insulating properties.

Field test data on another polymeric additive, T, having a chemical structure similar to that of V.I. Improver P, confirmed the fact that materials of this type form deposits which result in high octane requirements in actual service. (Additive T has both V.I. improver and detergent properties.) The increased octane requirement data are shown in Table 7.

These data confirm the fact that careful selection of additives used in lubricating oils is required to avoid excessive combustion-chamber deposit formation and octane requirement increase.

Go Light on Right Detergent

The problem of finding a completely non-contributing detergent-inhibitor additive has yet to be resolved. However, by proper selection of detergent and by use of suitable low viscosity base stocks of controlled volatility, detergent oils giving low octane requirements can be formulated.

A number of detergent-inhibitor additives have been evaluated to date in these studies, all of which contributed to some extent to combustion-chamber deposits. However, our field studies have shown that it is possible to make finished oils giving relatively low increases in octane requirement.

For example, field tests were carried out on a finished lubricant based on the narrow cut, solvent extracted Mid-Continent distillate (65 SUS viscosity at 100 F) referred to previously. The finished oil contained 5% of Detergent-Inhibitor R, V.I. Improver M, and a pour depressant. (Detergent-Inhibitor R is a well-known, widely used metal-containing additive.)

With isooctane as fuel, the oil blend containing these additives gave an equilibrium octane requirement of 83 in the controlled field tests. This compares with an equilibrium octane requirement of 90 obtained under the same conditions with Mineral Oil A. In this case, Detergent-Inhibitor R actually added about 7 octane numbers to the requirement (76) obtained with the straight narrow cut distillate plus V.I. Improver M. Even so, the performance of the oil containing the detergent-inhibitor is superior to that of the straight SAE 10 grade Mineral Oil A. (See Table 8.)

In further experiments, it was found that the equilibrium octane requirement with blends containing a higher concentration of Detergent-Inhibitor R increased markedly as additive concentration

Table 6—Effect of Viscosity Index Improvers on Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

Lubricant	Viscosity of Blend SUS/210 F	Equilibrium Octane Requirement	Deposits Weight g	Deposits Volume cc
2.6% V.I. Improver M in Low Viscosity Distillate	48.8	76	4.8	3.7
Synthetic Oil Y	48.6	78	2.3	0.9

Table 7—Effect of Additives on Combustion-Chamber Deposits Controlled Field Test; Isooctane Fuel

% Additive in Low Viscosity Solvent Extracted Mid-Cont. Base Stock	Equilibrium Octane Requirement[a]	Deposits Weight g	Deposits Volume cc
2.6% Additive M	76	4.8	3.7
5% Additive T	86	8.6	5.9

[a] Average initial requirement about 78

Table 8—Effect of Detergent-Inhibitor Additive Concentration On Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

% Additive in Low Viscosity Solvent Extracted Mid-Cont. Base Stock[a]	New Oil Sulfated Ash Content Wt. (%)	Equilibrium Octane Requirement[b]	Deposits Weight g	Deposits Volume cc
None	0	76	4.8	3.7
5% Detergent-Inhibitor R	0.54	83	16.1	9.8
14% Detergent-Inhibitor R	1.45	88	24.8	16.6

[a] Contains V.I. Improver M
[b] Average initial requirement about 78

Fig. 3—Equilibrium octane requirement increases markedly as detergent-inhibitor additive content is increased

was increased. This is illustrated in Fig. 3. It will be noted that increasing the concentration of the detergent additive from 5 to 14% increased the equilibrium octane number requirement from 83 to 88. There was a corresponding increase in the amount of deposits formed.

These data suggest that an optimum balance exists between the minimum additive level required for detergent purposes and the maximum that can be tolerated from a combustion-chamber deposit standpoint. Careful selection of the proper concentration and type of additive is required to obtain the best possible overall performance.

It should be emphasized that the above data were obtained with a non-contributing fuel (isooctane). With a leaded commercial fuel, the adverse effect of increasing the detergent additive content might be less easily observed.

Oil Oxidation Products Play Minor Role

One additional factor investigated briefly was the effect of oil oxidation products on deposits formed.

In an early test with a naphthenic base oil it was noted that the octane requirement level determined immediately following an oil change was lower than the requirement determined immediately prior to the oil change. This was not observed with the paraffinic oil.

Since naphthenic oils are known to be inherently unstable towards oxidation, it was felt that the high octane requirements observed just prior to oil changes might be caused by oil oxidation products contributing to combustion-chamber deposits. It was considered possible that if these oxidation products could be eliminated, essentially no octane requirement increase would be observed.

To throw light on the possible effect of oil oxidation, the naphthenic oil was re-evaluated, again using isooctane as the fuel. In this experiment the oil was redistilled prior to use to eliminate any oxidation products that might have built up in storage. To cut down on oxidation products developing in the oil during the course of the test, the oil was inhibited with a phenolic antioxidant. To further insure that oxidation products did not build up in the oil during the test, the crankcase charge was changed every 1000 miles, instead of every 2000 miles.

This procedure eliminated the drop in octane requirement increase due to the oil change. However, it had no effect on either the equilibrium octane requirement or amount of deposits formed.

These data indicate that oil oxidation products are not a major factor in the formation of combustion-chamber deposits.

Table 9—Effect of Chromium and Manganese Compounds in Lubricating Oil On Combustion-Chamber Deposits Controlled Field Tests; Isooctane Fuel

% Additive in SAE 10 Grade Solvent Extracted Mid-Continent Base Stock	Equilibrium Octane Requirement	Deposits Weight g	Deposits Volume cc	Deposits Density g/cc
None				
0.25% Cr Naphthenate plus	90	27.0	22.5	1.20
0.25% Mn Naphthenate	90	21.1	13.2	1.60

Combustion Catalysts Little Help

An oil additive which would remove combustion-chamber deposits or render them harmless would be the ideal solution to the problem. Considerable effort has been devoted to finding such an additive.

Data reported by the Standard Oil Company of Ohio indicated that compounds containing chromium and manganese were promising as combustion catalysts for use in mineral oils. However, in a controlled field test carried out with isooctane as the fuel, the same equilibrium requirements were obtained for the SAE 10 grade Mid-Continent Mineral Oil A containing 0.25% chromium naphthenate and 0.25% manganese naphthenate as were obtained with the base stock alone. (See Table 9.)

It will be noted that the deposit weights and volumes are considerably lower for the cars operated on the lubricating oil containing the chromium and manganese salts. Despite this reduction in deposits, the equilibrium octane number requirements are about the same. Why this reduction in deposits was not accompanied by lower requirements is not known. It does indicate, however, that the physical and chemical nature of the deposits, as well as the amount of deposits, may be an important factor in determining their effect on octane requirement increase.

A large number of other additive materials has been evaluated in the lubricant. To date, none have been found which appear promising enough to warrant extensive study.

In summary, then, the data obtained with a non-contributing fuel indicate clearly the approach to making a non-contributing lubricant. This lubricant would consist of a low-viscosity neutral distillate, thickened with a suitable V.I. improver rather than with bright stock. To make a satisfactory

finished lubricant, the formulation must also contain other additives, such as detergent-inhibitor, pour depressant, and so on, which are also selected to give as little increase as possible in octane requirement. Oils of this type can be made to have unusual temperature-viscosity relationships and to fit the SAE 5W-20 or 10W-30 viscosity classifications.

With a non-contributing fuel such as isooctane, such products have an octane requirement advantage of about 6–7 octane numbers over conventional SAE 10 motor oils. With a leaded commercial gasoline, they also show a definite, although smaller, advantage. On the average, compared to a conventional SAE-10 mineral oil, this advantage will be as much as 4 octane numbers in equilibrium requirement. This will be true with respect to either the detonation or preignition requirement.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Excerpts from Discussion by

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GM Research Laboratories

EXPERIENCE at the Research Laboratories Division of General Motors is in general agreement with the data presented by the authors covering the effect of different lubricants on knocking and autoignition tendencies. We wish to suggest, however, that there may be exceptions to the generalizations made with respect to the effects of volatility and base stock composition.

Our investigations of the effects of volatility and composition have been conducted using a modern V-8 engine of 8.25 compression ratio. This was operated on a 100-hr dynamometer cycling schedule found to reflect the behavior of crankcase oils in service. The engine was operated at 2000 rpm and 12 bhp, using the manufacturer's light-load spark advance and air-fuel ratio. Every 30 min the throttle was opened fully for 15 sec. During this time normal power mixtures were delivered by the carburetor, and spark advance was retarded slightly from borderline knock. Every 10 hr Research octane number requirement in terms of commercial type reference fuels was measured at manufacturer's 2000 rpm full-load spark advance and mixture ratio. A commerical premium-grade gasoline was used during all other phases of the operation.

Table A shows results obtained using two identical, narrow-range, distillation cuts from a paraffinic and a naphthenic base oil. The more volatile cuts distilled between 392 and 473 F at 10 mm Hg. The higher boiling cuts distilled between 473 and 554 F at 10 mm Hg. As can be seen, the viscosities of these oils differ considerably. The lower viscosities of the paraffinic distillates are due to the fact that for a given boiling range paraffinic oils have lower viscosities than naphthenic oils. These oils were tested in the engine without thickeners or other additive treatment.

For the two paraffinic cuts, the equilibrium Research octane number requirement is slightly higher for the lower boiling fraction. In contrast, the deposit weight is lower for this more volatile fraction.

Compositions of these two cuts, as determined from hydrocarbon type analyses, are very similar. Octane requirements are reversed from what might be predicted on the basis of the generalized effects of volatility expressed by the authors. Since similar effects were observed for the two cuts from the naphthenic base oil, it appears that, compared in this way, the results cannot be explained either in terms of volatility or composition as measured by hydrocarbon type analysis. It is possible that more detailed chemical analyses of these cuts would be helpful in explaining these unusual effects.

Considering the low boiling cuts from the two different base stocks, it can be seen that the equilibrium requirement and deposit weight is lower for the naphthenic base than for the paraffinic base oil. The difference in deposit weights is considerable. Similar differences were found for the two high boiling fractions.

In these comparisons, the volatilities are the same. The aromatic and naphthenic contents of the corresponding distillation fractions are higher for the naphthenic base oil than for the paraffinic base oil. In this case, where there is a wide variation in composition, it may be possible to attribute the differences in the effects due to the deposits to the effects of oil composition.

In conclusion, it is apparent there is still evidence which conflicts with the generalizations made with respect to the effects of oil volatility. As long as these conflicts remain unexplained, there is still much to be learned. When we are able to make all of our theories consistent with all of the experimental evidence being accumulated, we will then be able to say whether or not volatility is the principal lubricant factor by means of which the harmful effects of combustion-chamber deposits can be controlled.

Table A—Dynamometer Tests Results with Paraffinic and Naphthenic Base Fuels

Oil Type	Paraffinic Base		Naphthenic Base	
Boiling Range, 10 mm Hg	392-473 F	473-554 F	392-473 F	473-554 F
Viscosity, SUS				
100 F	69.1	140.5	171	487
210 F	36.1	42.7	41.5	51.8
Viscosity Index	86	105	-5	0
Oil Composition				
% Paraffinic Carbon	63	66	38	40
% Naphthenic Carbon	28	26	42	41
% Aromatic Carbon	9	8	20	19
Rings/Molecule, Av	1.5	1.8	2.8	3.1
Molecular Weight, Av	295	370	292	328
Deposit Weight, gm	48.1	60.1	27.1	36.9
Equilibrium Res. Octane No. Requirement	89.5	88.3	87.3	86.7

Not Enough Good Managers

. . . industry must *make* more

INDUSTRIAL expansion has brought to industry a growing shortage of good managers, starting from the first level up to the top of an organization.

To find and develop good managers, some reasonable method is needed to determine if a person measures up to what is required. And it is every management's responsibility to have a program that will provide the replacements necessary at all times, because of deaths, retirements, and terminations.

This program should begin at the pre-foreman level. The first step is to chart the path of advancements to the top managerial positions, compile what qualifications are required for each job in every level of the line organization, and then look for the applicants who have the best qualifications.

In the old days men often were selected on intuition, but the new trend is to make use of all available selection techniques. One company, for example, considers the following qualifications in selecting supervisory personnel:

1. Intelligence: This refers mainly to what the person knows, and might be classed as educational background. Actually, it is based on "Has the applicant the ability to reason and think out problems?"

2. Health Status: The applicant must be in good physical health and be able to pass a medical examination.

3. Motivations: The applicant must have the desire or determination to get ahead. He must have personal goals plus a desire to get ahead in the management field.

4. Adjustment: This will show the extent to which the person has been able to fit in with groups and situations. His past history will give some indication of adjustment.

5. Other Qualifications: This can be appraised from the past history of the applicant.

Once, technical know-how was enough to warrant selection, but now the applicant needs the ability to get along with people as well.

Companies should not fail to consider potential in all areas of their employed people. Experience has shown that union men promoted to the management field can be very successful.

In selecting for the first line level, it is essential to start with a job analysis.

Example: A foreman is expected to—

1. Meet his schedules.
2. Know his people.
3. Know the job.
4. Treat his people properly.
5. Have good communication with his people.
6. Keep his costs down.

Most companies agree that selection techniques should be adjusted to job requirements. So, management must be impressed with the fact that *more emphasis must be placed on job analysis—which in turn must be coordinated with the selection of the applicant.*

Direct responsibility for selecting should rest

Are Born . . .

to get good management teams

O. A. Hanna, McKinnon Industries, Ltd.

Based on secretary's report of Panel on Selection and Training of Technical and Supervisory Personnel of the Production Forum at the SAE International Production Meeting, Toronto, October 29, 1953. (It is available as part of SP-305 from Special Publications Department. Price: $1.50 to members; $3.00 to nonmembers.)

with the line organization in cooperation with staff heads and service department.

Companies endowed with men of potential should transfer them from job to job, so they may acquire wide experience and be available for future vacancies with more responsibility.

Testing

Psychological testing is used in selection by a majority of progressive companies, but it is only one of the many tools. Tests can be of value only as instruments to tell something about the person.

According to one major company, any testing program should be administered by a fully qualified person, preferably by a person with a doctorate in psychology, to minimize error.

Listed below are some of the items that can ensure successful psychological test administration:

1. A fully qualified man must be on hand to give tests; a man who has confidence in himself and ability to instill it in applicants.
2. Applicants must be fully informed about the testing program.
3. Applicants must know that they are not jeopardizing their present jobs by taking the tests.
4. There should always be a relaxed atmosphere.
5. It is essential to start the test series with a test of no time limit.
6. Everybody in the participating group should know everybody else.
7. Prior to enrollment, any participant with a special problem should have it taken care of.
8. The supervisor of the applicant to be profiled should discuss with him the reasons behind profiling.

Training

Basis of the personnel training program in one major company involves:

1. Appraisal of company organization chart;
2. Inventory of the persons to be considered for training;
3. Knowledge of potential of the persons considered;
4. Appraisal of each prospect by his immediate supervisor and higher management;
5. Records retained by a plant coordinator.

If time is short, training is made in a specific field.

Continued on Next Page

If a longer time is available, training should be made on a general basis.

Management should make certain that there are jobs available for the trained personnel. It doesn't make sense to train a man if there isn't a place for him to advance. Neither does it pay to mislead an employee on his chances for promotion, or, in reverse, to train the wrong man. However, if the surplus is only a small percentage, these people could be transferred to special assignments. If too large a surplus results, turnover is to be expected.

The consensus was, *"Keep the supply in line with the demand."*

Technical Personnel

Industry's ever increasing demand for men who will make decisions about tomorrow's complicated manufacturing equipment has lead management toward hiring engineering graduates. All plants, large and small, have practically identical programs. They can be broken down in the following phases:

1. Selection and Introduction
2. Training
3. Placement
4. Follow-up.

The training program is similar to that of the management group in introduction and administration, with the program outlining the opportunities within the organization.

Most companies are employing engineers in time study, drafting, and other fields that don't require full engineering training, thus accentuating the shortage of engineers. Management, in helping to overcome this problem, must make a careful analysis of the engineers in their employ, and the jobs they perform. One plant, in studying and breaking down engineering jobs, found that most jobs could be divided, thereby creating another job that could be capably performed by a person with mechanical aptitudes but without formal engineering training. That left only the creative type of work to the engineer.

Technical people should be exposed to the same training as other applicants for management jobs.

Evaluations

Through training, persons acquire new knowledge, new points of view, and an ability to cope with ever increasing responsibilities.

Here are questions that arise in evaluating a training course in the human relations field:

1. Do the participants accept it?
2. Do they know what was in the course?
3. Do they apply its principles?

Such a program should:

1. Create better morale.
2. Make for better communication.
3. Make for better production.
4. Reduce cost.
5. Reduce turnover.
6. Reduce absenteeism.
7. Prevent grievances.
8. Help to know people better.
9. Make for better job training.

One major company, in attacking excessive turnover, selected two groups in a division which had the highest turnover and exposed one of these groups to a course in human relations. Subsequently the trained group showed less turnover than the untrained group.

Experiments were also carried on with respect to absenteeism. Results were again favorable, despite layoffs, model changes, and fires.

Careful selection, adequate training, and provision for job opportunities are the necessary requisites for the successful development of the managerial team.

Experienced Personnel Executives . . .

. . . formed the panel of experts under whose guidance were developed the discussions which brought out the ideas summarized in this article. They were:

R. L. McMurray, Leader,
McKinnon Industries, Ltd.

O. L. Crissey,
General Motors Institute

Robert Teasdale,
Atlas Steels Ltd.

O. A. Hanna, Secretary,
McKinnon Industries, Ltd.

H. A. Pilkey,
The Carborundum Co.

E. R. Complin,
Canadian Industries, Ltd.

R. F. Howsam,
Studebaker Corp. of Canada, Ltd.

R. M. Robinson,
Canadian General Electric Co.

Machining Advances Forced By New Landing Gear Needs

G. E. Beringer,
General Factory Manager, Aircraft Section,
Bendix Products Division, Bendix Aviation Corp.

Excerpts from paper "Manufacturing Requirements for Producing the Modern Landing Gear" presented at SAE National Aeronautic Meeting, Los Angeles, October 1, 1953.

LANDING gear manufacturers have to learn to live with tighter manufacturing limits and continued pressure for weight reductions. That's why metal cutting is now a focal point in landing gear manufacture.

Three factors combine to point up the machining problem: (1) available forgings still carry too much parasitic weight, (2) designs specify pretty restrictive dimensional tolerances, and (3) more finicky surface finishes are demanded.

Machining on a three-dimensional contour milling machine, like the Keller, is one practical answer to these needs. When it comes to ultra high-strength steels, a few slightly different techniques have to be used. But the big need is for machining methods that take control of the process out of the operator's hands and put it into the machine. Some of these are on the way.

1. Kellering
It's Suitable, But . . .

Production use of a machine such as the Keller offers one practical solution to the machining problem at present production levels. But it can become pretty costly for certain kinds of stock removal unless the proper type machine is used.

This machine uses an exact duplicate of the part to be produced as a template, and reproduces it accurately to tolerances of ± 0.010 in. Fig. 1 illustrates the Kellering of a large aluminum forging. The slight irregularities left by the progression of the cutter are generally removed by hand finishing operations known as barbering.

In addition to eliminating excess stock, certain other benefits may be obtained from this type of contouring operation.

1. Operations normally performed by conventional machining methods may often be combined with the contouring operation at no extra cost, and with a saving in set-up time and tooling.
2. A contoured forging does not require targeting

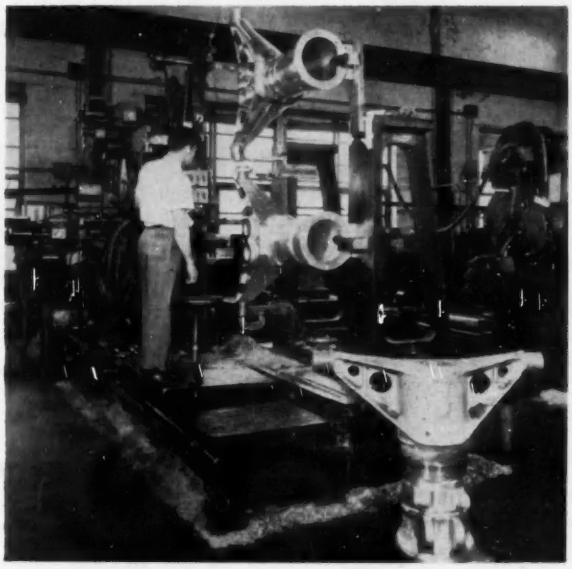


Fig. 1—Three-dimensional Keller countering of large aluminum alloy forgings is one answer to the landing gear manufacturer's machining problems

for final machining operations. External lugs and bosses are machined to exact size, and in correct location. Result: reduced tooling and operational cost.

3. The combination of contouring and barbering finish provides a method of eliminating scale defects, decarburization, and improving surface finish.

Some indication of the cost of Keller contouring may be obtained from Fig. 2, a plot of cost data available for a limited number of experimental and production items. The rather wide spread between the arbitrary limits define the scatter of the cost data for Kellering steel parts. It's evidence that factors in addition to pounds of material removed have a significant effect upon the operation. In general, contouring costs are increased by:

1. The increase in traverse area per pound of stock removed.
2. Increasing complexity of the area contoured.
3. Increasing material hardness. Cost of Kellering heat treated parts in the 180,000 to 200,000 psi range may be double the cost of Kellering normalized parts.
4. Increased number of set ups.
5. Increased amount of barbering.

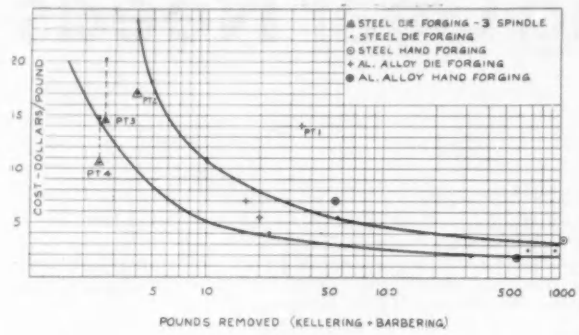


Fig. 2—There's a relationship between the cost of Keller contouring and the amount of material removed, as these data for aluminum alloy and steel show

Results of a Keller study made to determine the cost of removing the excess stock on a single spindle Keller from a cylinder shown in Fig. 3.

An approximate cost reduction of 40% can be realized on this particular item when Kellered on a three-spindle machine. This information is included on Fig. 2 as points 2, 3 and 4.

Point 1 on Fig. 2 represents the cost of contouring the aluminum trunnion shown in Fig. 1. The cost per pound for the Kellering of this part is considerably higher because of the necessity for maintaining flange thickness dimensions. These require numerous set up changes in order to remove the maximum excess stock.

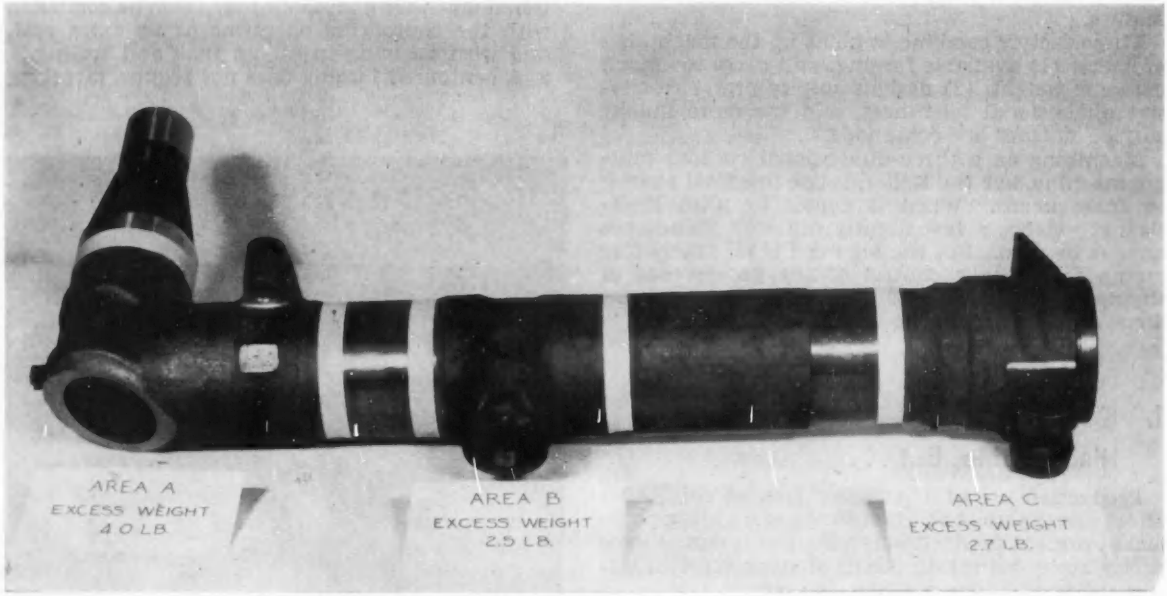


Fig. 3—Shown here is the excess weight on a contemporary landing gear cylinder due to forging tolerances. This cost of removing this excess stock is as follows:

Area	Weight Removed (in pounds)	Cost (in dollars)	Cost (in dollars per lb)
A	4.0	95.40	23.85
B	2.5	37.20	14.90
C	2.7	54.40	20.20
Total	9.2	187.00	20.30

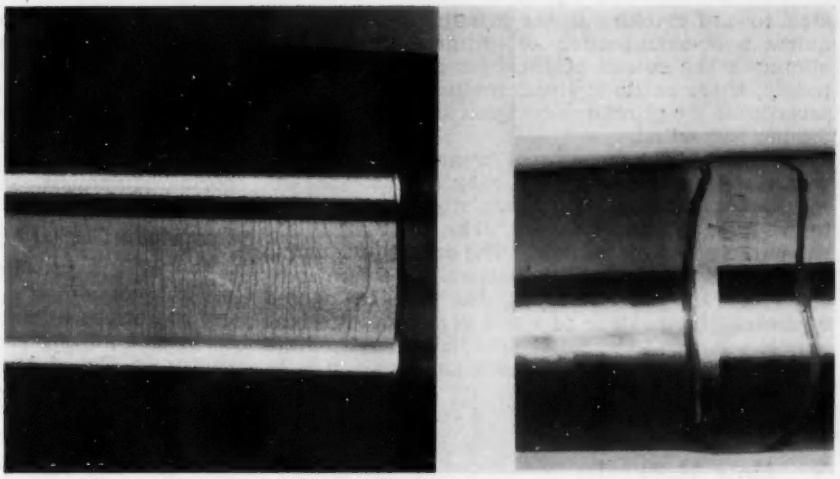


Fig. 4—At left are shown severe grinding cracks, an inherent danger with ultra high-strength steels. The condition at right is more typical

2. High-Strength Steels: Heat Treat Affects Machining

Landing gear components manufactured from high strength steels in the 220,000 to 240,000-psi tensile strength range are in production today. Experience with the machining of these parts has indicated that:

1. Turning, milling, drilling, and tapping operations can be performed with available cutting materials, but require significantly reduced surface speeds.
2. Surface finishes obtained by milling and turning operations are as good as, or better than, those obtained on lower strength steels.
3. Grinding and plating operations have become an increased hazard. There is a greater tendency toward "grinding cracks" if these operations are not subject to close process control.

It can be expected that machining difficulties will become more severe as the material hardness approaches the levels associated with the ultra high tensile strength of 300,000 psi. Since stock removal by available machining methods at this hardness will take considerable time, it is desirable to reduce the machining after heat-treatment to a minimum. The amount of material which must be provided for finish machining operations is largely a function of the distortion effect of heat-treatment upon the unit.

In general, parts are now being heat treated by austenitizing in a partially-controlled atmosphere, quenching in oil and tempering in air. This technique results in certain amounts of scale, decarburization, and significant distortion of the parts. That's why revised heat-treatment processes are required for the ultra high strength steels if machining after heat treatment is to be effectively reduced.

Hardness Begets Cracks

The tendency toward the development of grinding cracks increases with increasing hardness levels. This cracking is typically a form of stress corrosion embrittlement crack. It's the result of stresses produced by surface heating or, in severe cases, through the rehardening of certain areas. The hardened areas are untempered martensite and are particularly susceptible to cracking.

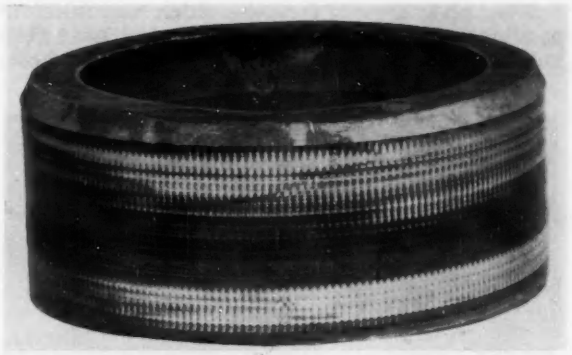


Fig. 5—Surface temper etching of a high-strength steel cylinder shows a "grinding burn" pattern on a ground section. The very light areas are rehardened surface material. The darker areas have been retempered

Fig. 4 shows two examples of grinding cracks. On the left is a photograph of a severe condition, while the picture on the right illustrates a more typical pattern. These cracks were detected after the parts were chrome plated and ground. The photograph on the left was taken after removal of the plate.

Stress relieving heat-treatments have offered some reduction in cracking during subsequent plating operations. Treatments in the 375 F ranges have proven generally inadequate, whereas 700 F treatments have proven satisfactory. Limited experience with relief treatments in the 400 to 500 F ranges, indicates that this thermal treatment may not prevent cracking.

In the 180,000 to 220,000 psi range, grinding cracks have typically developed during the plating operation. However, in the 220,000 to 240,000 psi range, certain instances of crack formation during grinding have also been reported.

The expected tendency of the ultra high strength

steel toward cracking in the grinding operation requires a re-examination of grinding practices to eliminate the causes of the over-heating. Fortunately, there exists a visual method of rating the severity of the grinding operation known as surface temper inspection.

This technique consists of treating the surface with a mild etching solution. Fig. 5 illustrates the results of a surface temper inspection on part of a high-strength steel cylinder. The light areas are the untempered martensite. The dark bands define retempered material. This particular pattern indicates that the excess heating was probably caused by a changing pattern of wheel pressure. Presumably it was due to wheel or spindle unbalance, and possible eccentricity and dimensional variation in the part.

3. New Methods: Feature Greater Control

Selection and use of facilities which have inherent possibilities of improved process control have been indicated in the considerations of salt bath heat-treatment and methods for removal of excess forging stock. Production machining facilities used in landing gear manufacturing have generally been of the type where control of the process lay within the hands of the operator. Efforts to improve productivity and reproducibility have focused attention on tracer controlled types of milling, turning, and boring equipment.

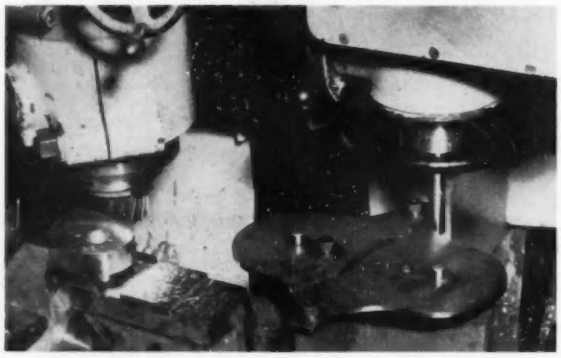


Fig. 6—Typical of the newer landing gear machining techniques is this operation. Here a tracer-controlled vertical milling machine is contouring a trunnion lug on an outer cylinder

Combined Operations

Use of the two-dimensional contour mill often permits combining a number of conventional milling operations into a single operation. In addition, controlled milling of radii similar to the operation shown in Fig. 6 becomes a simplified procedure. Significant cost reduction can be obtained by use of contour mills with multiple cutting heads. Tracer type lathes are used to maintain dimensional control of tapered, blending, and radius machining operations associated with turning and boring.

Improved quality and reduced costs often may be obtained by refinements in existing processes and by substitution of processes which are more readily controlled. Improvements in techniques employed for producing long close tolerance bores and "bottle" type bores illustrate this principle.

Long Bores Made Easy

Deep boring of open-ended cylinders is generally performed on long bed turret lathes using boring bars which are piloted by passing an extension of the bar through a bushing in the headstock spindle. This method of boring produces reasonably accurate holes; but it is subject to chatter and reduced tool life when heavy cuts are taken. Exceptionally long lathe beds and increased floor space are required for clearance when this type of bar is used. Blind hole boring is generally accomplished by the use of stub bars.

To obtain size control and increased productivity, the landing gear manufacturer has resorted to the use of pack boring for blind and regular boring. The pack bar is similar to a stub bar, except that a guide called a pack is located immediately behind

Pack Bar Eases

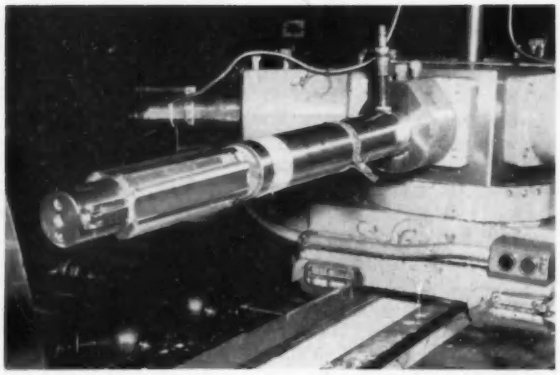


Fig. 7—Pack bar is used for boring close tolerance holes. Note the antiwear material in the wooden guide

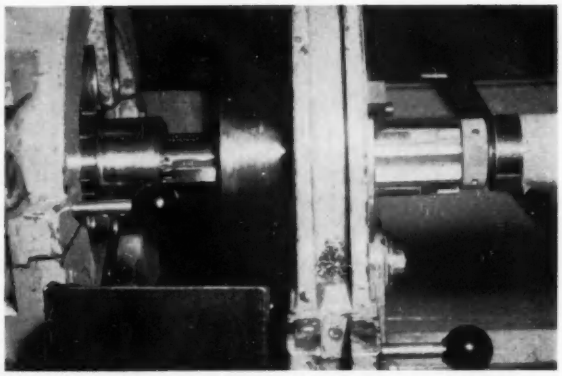


Fig. 8—Initial operation in pack bar boring is to guide the bar through bushing to insure accurate starting

the cutting tools. The length of the pack bar is substantially less than spindle bushing piloted boring bars and shorter bed lathes can be used.

Typically, the pack guides are made of impregnated wooden strips which are firmly mounted in retainers. Wooden guides are used because they yield slightly when the pack is forced into the cylinder. In addition, they dampen vibration which results in finer finishes.

Pack bored holes can be consistently reproduced to tolerances of ± 0.002 in. with finish of 150 microinches in high strength steels, if alignment of equipment and accuracy of cutting tools and packs is maintained. One drawback of wooden pack guides is the reduced life which may require replacement of the guides after a very small number of holes have been bored. Substantial increases in pack life as much as 10 to 20 times have been obtained by inserting wear resisting material into the wooden guides. Figs. 7, 8, and 9 illustrate the initial operations in pack bar boring.

Fig. 7 shows the design of the pack guides with the inserted material. Coolant is transmitted through the bar, and is discharged at each cutting tool in sufficient quantity to wash the small chips through the space provided between the guides.

Fig. 8 illustrates the initial step in the boring process. A guide bushing of the same size as the finished bore is mounted immediately in front of the work, and is used to guide the bar.

Fig. 9 shows the continuation of the process after the part has been bored to a sufficient depth to permit the guiding of the tools by the pack. The guide bushing has been removed to provide clarity.

Tricky Tapers

Bottle and taper bores are generally produced by stub bar tooling which permits movement of the bar axis transversely to the work axis to obtain the variation in internal diameter. Taper attachments and tracer equipment have been used. Finishes obtained are subject to chatter and undercuts unless extraordinary care is taken and light cuts are used. The bottle boring operation becomes difficult when the neck section of the bore will not permit the entrance of an adequate sized bar.

Deep Boring

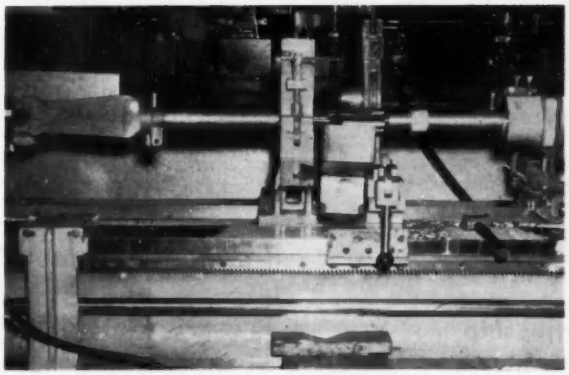


Fig. 9—This is the set-up for pack boring a landing gear cylinder once operation has been started

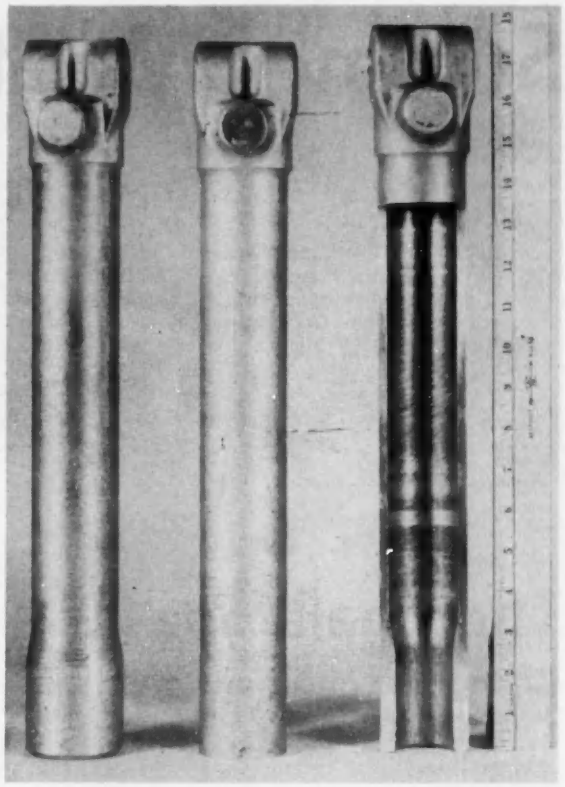


Fig. 10—Shown here are the steps in forming a bottle bore in an aluminum alloy inner cylinder. First a straight hole is bored. Next, outside diameter is machined to predetermined diameter. Finally, contoured material is "squeezed" in to get bottle effect

Sections equivalent to those obtained by bottle boring can be produced, in some instances, by a production method which results in improved control of finish quality and reduced cost. Essentially this process consists of:

1. Producing a straight hole through the part to the maximum diameter required in the bottle section of the finished part. Any desired finish can be easily achieved by boring and honing if necessary.

2. Machining the outside diameter to a predetermined contour.

3. Displacing the contoured material from the outside to the inside to obtain, in effect, the bottle bore desired.

Fig. 10 represents the steps in the production of a bottle bore produced in an aluminum cylinder by this method. Extension of this process to larger sized members has been accomplished.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Summer Meeting Report

continued from page 17

Summer Meeting also featured the kickoff of SAE's 50th birthday next year. William Power, creator of the winning design in the SAE Golden Anniversary Emblem Contest, was presented with a certificate and $200 award for his prize-winning entry.

The sports and social calendar was designed to suit varied tastes. Golf, swimming, fishing, trap and skeet shooting, and boardwalk strolling furnished recreation for many. Bridge, canasta, and a fashion show for the ladies, together with dancing at night, rounded out the program of events.

The Challenge Ahead... in automotive engineering.

Changing conditions create new horizons for engineers.

NEWTON was right in more ways than he knew when he said that every action brings an equal and opposite reaction. His law works just as well in the automotive engineering process as it does in physical phenomena, judging by Summer Meeting discussions.

Ever-changing situations demand shifts in the engineering stance on automotive products, create challenges for the designer. The Atlantic City conclave pointed up the three kinds of challenge-producing changes . . . changes in conditions, changes in human relationships, and changes in physical phenomena.

1. Man-Made Changes

In many ways the engineer finds man his own worst adversary. And vehicle brakes are a case in point. On the one hand customers want faster, heavier, more luxurious riding cars and larger trucks with greater load-carrying capacities. But enforcement authorities keep demanding short stopping distances.

The brake engineer is caught in a squeeze. As vehicles get larger and heavier, the stopping distance restrictions become an ever-tightening noose around the brake man's neck. As a criterion of stopping ability, 30 ft from 20 mph seemed reasonable years ago when it came to prominence. It's no longer realistic with the increase in speeds and weights since then.

The brake man says this limitation has forced a realization of factors other than brake equipment that enter into the ability "to stop a little sooner." He says they are: the driver, vehicle condition, weight shift, tire capacity, and road condition.

He's supported in this by results from Bureau of Public Road tests that show proper maintenance can make a big difference in brake performance, especially for commercial vehicles with stopping distances of 50 ft or more from 20 mph. Eliminating slack between linings and drums seems to be the most important maintenance operation.

The brake engineer accepts his responsibility of improving brakes. But he still feels his job would be easier if operators got the most out of existing equipment with proper maintenance.

2. Human Relationship Changes

The second challenge-maker, the human side of engineering, stems from the growing complexity of automotive technology. Technical progress brings with it an increasingly high degree of specialization. And to produce an automotive product takes more and more coordination of more and more specialists. The more specialists involved, the more coordination needed.

Typical of this is the relationship between passenger car stylist and body engineer. Each must understand and appreciate the other's problems. Neither can function effectively without the full-fledged cooperation of chassis engineer, engine designer, and the many other specialists who contribute to the vehicle.

The continual introduction of new automotive advances will accent the need for even more automotive engineering teamwork as time goes on.

3. Changes in the Nature of Things

When man changes things, he often forces nature to modify its way of doing things. Nature's change may not be desirable, so man has to determine how to cir-

cumvent it. And so it is with preignition.

Preignition wasn't much of a problem until the advent of current high compression ratio engines. Now the phenomenon looms important because it limits the power output of these engines.

It has engineers literally turning handsprings trying to explain its mechanism and to figure out how to prevent it. Reports at Atlantic City revealed that engine and petroleum engineers have broken out a rash of instruments and investigative procedures to get a fix on this power-robbing bugaboo.

They're measuring it, photographing it, and simulating it. They're trying to find what brings it on, what effect it has, and how to get rid of it. Oscilloscopes and related instrumentation are worked overtime. Single- and multicylinder test engines are being put through their paces in laboratories and cars are burning up many thousands of road miles in an effort to corner this rogue called preignition.

Right now a few facts are beginning to emerge from this beehive of activity. But as yet, they're like unrelated pieces of a jigsaw puzzle. For instance, it has been found that:

- Increasing use of aromatics by refineries to get high antiknock quality leads to greater deposit ignition tendencies.
- Commercial phosphorous fuel additive reduces deposit ignition tendencies.
- Multigraded lube oils lend a hand in arresting deposit ignition.
- If spark timing is retarded from peak power, surface ignition may substantially boost power.
- A newly-developed carbon remover increases power output by 5 to 10% by eliminating preignition.

Although they feel they still have a long row to hoe, engineers agreed that comparing notes at Atlantic City brought them lots closer to meeting the challenge from preignition.

Following are highlights gleaned from papers, panel and round table discussions.

SAE's Maestro and His Lady

At the Summer Meeting, President Littlewood took a few spare minutes to indulge in a favorite hobby—playing the cello. Mrs. Littlewood seems pleased with the results

Brake Heat Prostration

A brake must, first of all, be adequate in heat capacity. It may have adequate torque capacity even if it cannot lock its wheel.

The time that it takes a brake to go to work is not a matter of the adequacy of the brake but of the system which operates and controls it. . .

. . . **J. G. Oetzel**, Warner Electric Brake & Clutch Co., "When Are Brakes Adequate?"

Stopping Trucks

Since 1942 there has been considerable improvement in the brake performance of the motor vehicles using our highways.

Vehicle stopping distances of 50 ft or more from a speed of 20 mph can be appreciably improved by the adoption of adequate brake maintenance programs. The elimination of slack between linings and drums is the most important maintenance operation.

The ordinary pipe street elbow is one of the worst offenders among the fittings which retard the flow of air through a brake system. . .

. . . **F. William Petring**, Highway Transport Research Branch, U. S. Bureau of Public Roads, "Improvement in Stopping Ability of Motor Trucks in Use on the Highway."

Please Turn Page

Cost Reduction

A management directive to the staff of the mythical Atlantic City Motor Truck Co. challenged it to cut manufacturing costs. Here are some of the moves that the staff proposed:

- Reexamine designs for possible savings through more efficient use of material and of production capacity.
- Pay more attention to salvaging material and tools.
- Give the purchasing department more time to negotiate with vendors so that it can get more favorable prices.
- Figure out what is needed to produce the predicted volume—and also what is needed for slightly higher and lower volumes.
- Invest available funds in more efficient plant.
- Standardize tooling.
- Take back into the shop whatever can be produced in unused capacity, if that is cheaper than buying from vendors.

. . . Round Table on **A Manufacturing Cost Reduction Technique From the Design Board to the Shipping Room.**

No Ivory Tower

Today, the stylist sets the shape of the car before the chassis and body engineers really enter the design picture.

A stylist need not be an engineer, but he must appreciate the problems of body engineering . . . and vice versa.

As for who is the car designer, the answer is both stylist and engineer. . .

. . . **Duncan McRae**, Kaiser Motors Corp. and Willys Motors, Inc. and **Kenneth E. Coppock**, Fisher Body Division, General Motors Corp., "Who Is the Designer—The Stylist or the Engineer?"

PREIGNITION . . .

It's Rich in Challenges for Researchers

Analyzing It

Our new engine analyzer is basically an oscilloscope, automatically synchronized to engine crankshaft position.

In contrast to conventional oscillograph equipment, the engine analyzer generates a multiple number of lines, one line for each cylinder of the engine.

Any engine function that can be transformed to an equal electrical signal by a suitable transducer may be displayed on the engine analyzer.

The analyzer has proved its value as a means of recognizing the presence and extent of preignition. . .

. . . **E. A. Martin** and **J. H. Goffe**, Socony-Vacuum Laboratories, "A New Engine Analyzer."

Fuel's Effect on It

Continuous or sustained deposit-induced abnormal combustion is definitely affected by fuel octane number, according to road tests using independent spark plugs as ionization gaps. This abnormal combustion can be eliminated by removing a portion of the combustion-chamber deposits.

Scattered or isolated abnormal explosions are not significantly affected by fuel octane number. They can be eliminated by removing a considerable portion of the combustion-chamber deposits. . .

. . . **J. R. Landis**, Research Laboratories Division, General Motors Corp., "Detection of Abnormal Flame Fronts in Road Tests with an Engine Using Independent Ionization Gaps."

Simulating It

Tests conducted in a single-cylinder engine using a second spark plug as a simulated source of surface ignition showed that:

1. Surface ignition can either reduce or increase the power output of an engine.
2. The magnitude of the increase in fuel octane quality needed to suppress knock which can be caused by surface ignition is largely a function of the spark-plug timing.
3. Surface ignition occurring well after the firing of the spark can have a considerable influence on engine performance. In other words, surface ignition need not precede normal ignition to exert a significant effect on performance. . .

. . . **L. B. Shore** and **J. F. Kunc, Jr.**, Esso Laboratories, Standard Oil Development Co., "The Effect of Simulated Surface Ignition on Engine Performance."

Chasing It

A new method removes combustion-chamber deposits by a combination of heat, impact, and scouring action. It involves the use of a special fuel which removes deposits as it burns.

Measurements of acceleration performance before and after a treatment show that 70 to 80% of the power loss due to deposits is usually restored.

Exhaustive tests have proved the complete compatibility of this deposit-removal method with present-day cars.

. . . **H. W. Sigworth** and **R. K. Stone**, California Research Corp., "Controlling Preignition by Deposit Removal."

Rating Tests for It

Use of the "key-off" technique is not always a reliable method for determining the presence of surface ignition.

Information obtained at retarded spark timing in preignition-limited engines may not accurately reflect the operation of the engine at normal timing.

After deposits had been accumulated in a laboratory engine under light-duty cyclic conditions, every instance of fuel failure resulting in engine noise was the result of surface ignition that led to knock. . .

. . . **Robert Meagher**, **R. L. Johnson**, and **K. G. Parthemore**, Petroleum Laboratory, E. I. du Pont de Nemours & Co., Inc., "Correlation of Engine Noises with Combustion Phenomena."

Spotting It

Preignition is easily recognizable with new laboratory instrumentation that responds to the external vibrations of an engine caused by preignition.

The complete instrumentation consists of a multi-cylinder knock analyzer, a recording translator, a dual-channel magnetic tape recorder, and a special camera.

Any vibratory event, anywhere in the engine, will show up on the trace of the cylinder being tested. . .

. . . **R. C. Bowers** and **A. R. Isitt**, Shell Development Co., "The Observation of Automotive Preignition and Knock."

Arresting It

Refinery trends that increase the aromatics in gasolines (to secure higher antiknock quality) lead to the formation of combustion-chamber deposits

which have greater deposit-ignition tendencies. This trend places further emphasis on the need for better lubricating oils and/or special fuel additives.

Use of a commercial phosphorus fuel additive will reduce deposit ignition.

The new volatile multigrade lubricating oils will reduce deposit ignition. . . . **C. A. Hall, J. A. Warren,** and **J. D. McCullough,** Ethyl Corp., "Practical Yardsticks for Deposit Effects."

Car Heating

The trend to V-8 engines doesn't have car-heater engineers exactly dancing in the streets. On the contrary, they're glum about the fact that V-8's don't dish up heat (from a cold start) as fast as 6-cyl engines. For example, after 4 min at 0 F ambient, the heater-water temperature of a 6-cyl car would be 122 F, but only 108 F with a V-8 engine car. Some auxiliary means is needed to lick this problem. Auxiliary devices that would give heat in the passenger compartment in 2 min. could command a $15 to $25 retail price.

. . . Round Table on **Car Heating and Ventilating.**

Smoother Riding Trucks

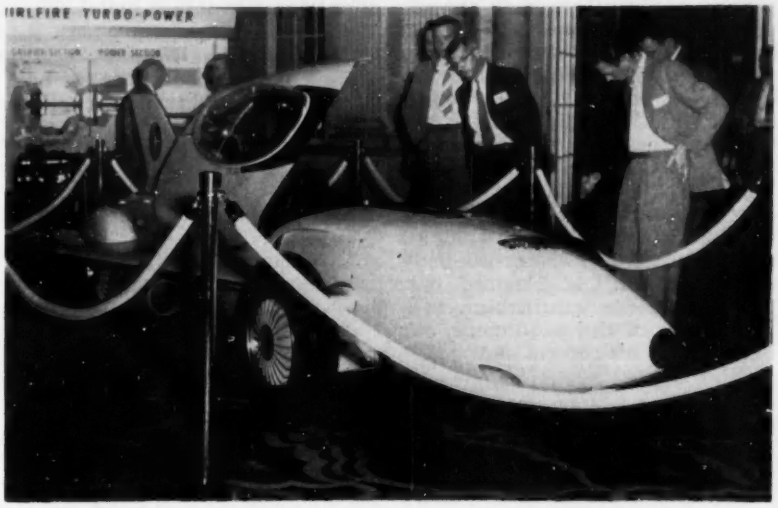
The greatest improvement in truck ride can be made by changes in the suspension.

Variable-rate springs may be one way to do it. But we must remember that they vary truck bed height—which complicates truck loading from platforms.

Wheel-plus-tire runout of as little as 3/16 in. can cause serious chassis bounce on smooth roads. One explanation is that on smooth roads, there isn't enough disturbance to overcome friction between spring leaves. So the one-per-revolution excitations from the tire are transmitted directly to the chassis as if there were no intervening springing.

. . . Round Table on **Riding Comfort in Trucks.**

GM Gas Turbine Engine



General Motors' sleek-bodied Firebird car, powered by a gas turbine engine, drew many "lookers." The demonstration rides in this vehicle came by way of colored movies at the technical session at which the car and its engine were described

Current Progress . . . in automotive engineering.

Today's problems are born of yesterday's successes.

HOMEWARD bound, one engineer gave the ocean a parting glance and mused how the waves breaking on the beach resembled the progress reports on automotive developments he had heard about all week.

Each wave, he observed, born of mighty forces out at sea, propagates succeeding waves, each less intense, less well defined than its predecessor. And so too, he observed, automotive developments generate severe problems at their inception, but each little success leaves in its wake a problem somewhat less severe, less distinct, until finally all troubles are dissipated in the face of the breakwater of research and development.

If problems were waves, then the land-bound gas turbine would be akin to a full-grown ocean hurricane. Engine men at Atlantic City see this form of powerplant as a raw rookie, full of tremendous promise, but lacking the refinements to yield its full potential of pent-up power.

A report on General Motors' entry in the gas turbine field showed that its vehicle powerplant has a weight-to-power ratio of about 2 lb per hp. That's about one-third that of a conventional piston engine. Installed in a bus, the GM gas turbine supplies nearly twice as much power as a diesel engine and weighs about 1500 lb less.

But the turbulent wave of problems surrounding the turbine are fuel economy, better acceleration time, and the need for a suitable dynamic braking system. (For a full discussion of the present state of the art on this development, see the article on page 18.)

Participants at the Meeting also heard how the gas turbine is creating a new concept in car engineering (another f'r instance of one wave propagating another.)

With 300 hp available at the rear wheels, a car powered by the GM turbine could attain high speeds.

So the experimental vehicle housing the turbine has to be clean aerodynamically, stable at all speeds, and have good weight distribution. The chassis on which it rides must furnish directional stability at all speeds, brakes that can absorb kinetic energy several times that of a Cadillac, clean design so that all of the chassis fits within the body shell. If the GM Firebird car, powered by the gas turbine, is a forerunner of things to come, car design is in for radical changes.

The "aged" piston engine is generating problems less intense, but farther-reaching, than those of the gas turbine. Engine designers and petroleum men are riding the crest of these waves with ways of squeezing more power from Mr. Otto's internal combustion machine. They have come up with fuel, oil, and engine innovations which bring the engine on the threshold of new gains.

For example, oil specialists feel they are on the brink of substantial advances for high compression engines with new multigrade lubricants. By adding viscosity index improvers to oil, they get the lubricity advantage of a low viscosity oil plus the higher oil mileage available from a high viscosity lube. Several researchers reported fuel economies of 10 to 15% with multigrade oils. On long trips, the gain is about 3%.

You can understand where the advantage comes from when this finding is revealed: It takes half as much power to turn over an engine with 10W-30 oil as with conventional 30 grade oil.

Another engineer wrapped up the multigrade oil package in these three plus values:

1. Reduced knock, preignition, and spark-plug misfiring.
2. Less mechanical and corrosive wear.
3. Greater engine cleanliness.

But even these versatile new oils bring with them a backwash of problems. Here are some of them:

- Some of the new oils "skip grades." For instance, with an SAE 10W-30 oil, the SAE 10W, 20W, and 30 viscosity ranges can be met; but it doesn't fit the SAE 20 requirements.
- One reason the multiple-viscosity grade oils were introduced was to cut down the number of oil grades. Engineers wonder whether this makes obsolete the SAE classification with its seven grades.
- The standard ASTM methods for determining viscosity won't work for the new oils. So more precise procedures are needed.

On the fuels side, petroleum refiners are ready, willing, and able to dish up lots of high antiknock quality in gasoline. They are up to their ears in an excess of light hydrocarbon fractions, such as butane, and will have even more in the future. These light ends are the things that high octane gasolines can be made of. But there's a hitch . . . and it's called vapor lock.

Tests show that postwar cars can handle volatile fuels better than prewar models. But the petroleum people wish cars today were even less vapor-lock sensitive.

Several engine researchers pointed up a way which may solve some of the problem. They found that the pressure drop through the valves of the fuel pump limited the pump's vapor-handling capacity. So they merely installed larger valves in the pump cover. Result: Reid vapor pressure of the fuel causing borderline vapor lock was increased by 3 lb.

Transmission men too chimed in with their parallel of "each success giving rise to a new problem." Their ability to produce an effective self-shifting transmission for passenger cars has whetted the appetites of heavy truck operators for a similar device. It has the transmission man

Seeing is Believing

That's what the perpetrators of the Automobile Air Conditioning Panel believed. So they brought to the meeting six air conditioned cars (two of which are shown above) in which they gave demonstration rides. Most engineers as those above were just as interested in the mechanical arrangement of the various systems as they were in the rides

searching for the ideal truck transmission design for versatile coverage and volume production.

Like the waves dissipating themselves on the sands of Atlantic City, so too automotive engineering puzzles of today are sure to be broken; but other new ones are certain to follow behind the old ones.

Following are highlights gleaned from papers, panel and round table discussions.

Racing Below the Border

The Mexican Pan-American Road Race provides the only place where cars can be tested on a highway nearly 2000 miles long at practically full throttle continuously.

While it's impossible for any customer to impose such abnormal demands on his car, it is gratifying for him to know of the extra reserve built into it.

For car manufacturer's, the Race serves as another accelerated test, verifying all those run prior to production release. . .

. . . **J. R. Gillette**, Lincoln Product Planning Department, Lincoln-Mercury Division, Ford Motor Co., "The 1953 Mexican Pan-American Road Race."

Self-Shifting Trucks

If within a given truck automatic transmission all planetary-gear ratio changes can be single transition shifts, the problem of attaining smooth shifts throughout the total range will be greatly simplified.

If it is necessary to effect double swap shifts (if more than one of the three ratio-controlling elements in a planetary gearset must change or if a single transition shift must be made in two planetary gearsets), then complications arise. . .

. . . **D. T. Sicklesteel**, Products Development Laboratory, Borg-Warner Corp., "Possibilities of Planetary Gearing for Full Torque Shifting Transmissions for Commercial Vehicles."

Still Need 7 Grades?

The trend to multi-viscosity motor oils brings up the question of whether the present SAE Crankcase Oil Viscosity Classification has become obsolete. Do present-day engines really need the seven viscosity grades now in the Classification?

Multi-viscosity motor oils seem to have compromised the reputation of ASTM Viscosity-Temperature charts. That's because viscosities extrapolated below 0 F are of questionable accuracy in the case of oils containing appreciable amounts of V.I. improver additives.

. . . **Carl W. Georgi**, Quaker State Oil Refining Corp., "Some Technical Problems Introduced by the New Trend in Motor Oils."

MULTIGRADE OILS:

Just How Good Are They?

Watch That Bench Test!

To prevent sticking of passenger-car hydraulic valve lifters, the oil need not have a high additive content or the ability to pass a test in a diesel engine. It does require additives designed to cure sticking due to both varnish and rust, however.

In developing and evaluating oils to protect against rust and to prevent wear, oils should be tested in an engine in which the problem exists—not in an arbitrary bench test. . .

. . . **F. S. Wood**, Research Department, Standard Oil Co. (Indiana), "New Oil Designs for New Engine Designs."

Engine Wear

Valve lifter-camshaft metallurgical combinations, engine design, lubricating oil, and engine operating conditions have a profound effect on valve-train wear.

The valve-train wear problem can be corrected more by changes in metallurgy than by changes in lubricants.

Anti-wear characteristics of lubricants, however, need to be improved. . .

. . . **H. L. Yowell, C. A. Weisel,** and **R. R. Risher**, Esso Laboratories, Standard Oil Development Co., "A Field Approach to Engine Wear."

C-C Deposits Less

Octane requirement increase and combustion-chamber deposit weights are lower with the new high V.I. oils than with conventional SAE 20-20W oil containing bright stock.

Fuel economy at 30 mph constant speed is slightly better using the new high V.I. oils than it is when a 100 V.I. lubricant of equivalent Saybolt viscosity at 210 F is used. The high V.I. oils seem to have no advantage in normal suburban highway driving.

Intake-valve deposits are heavier with the new high V.I. oils than with conventional lubricants. Whether these deposits are due to the V.I. improver or to failure of the volatile base stocks to wash the deposits from the valve backs is not known. . .

. . . **J. B. Bidwell** and **R. K. Williams**, Research Laboratories Division, General Motors Corp., "The New Look in Lubricating Oils."

New Lab Tool

There is a need for laboratory engine cleanliness tests that will yield results consistent with field experience.

It would be most desirable if one research engine could be used to evaluate the individual properties critical to the engine-lube oil relationship.

The timely appearance of the CLR engine, specifically designed for maximum flexibility, makes available an ideal tool with which to meet such a challenge. . .

. . . **F. T. Finnigan** and **P. E. Pfeifer**, Research and Development Laboratories, Pure Oil Co., "A New Approach to Crankcase Oil Development."

Gas Savings

Very real gasoline economies can be realized with multigrade lubricants.

Savings of from 5 to 10% would be expected for typical passenger-car driving at moderate ambient temperatures. For very short trip driving, or at low ambient temperatures, larger savings would be realized.

Gasoline savings appear to have a minimum value of about 3%, even for very long trips with fully warmed-up engines. . .

. . . **C. C. Moore, W. L. Kent, W. P. Lakin,** and **R. W. Mattson**, Research

Around the Meeting . . .

Just before the dance band stopped playing in Club 22 on Monday night, a bat joined the festivities. It set the whole company to reminiscing about the old days when Summer Meeting was held at French Lick, Indiana.

* * * * *

Ted Swanson, of the Ladish Co., told of visiting a plant recently where a designer-draftsman was asked why he showed only 30-deg angles in his drawings. "I've been too busy to get myself a 45-deg triangle, he replied. . . . And Swanson told of another draftsman who specified only small radii fillets on his drawings for forgings. His alibi: His colleague along side had borrowed his large compass.

* * * * *

All eleven technical sessions were smooth productions, thanks to these chairmen: **E. P. Gohn,** Atlantic Refining; **H. F. Copp,** Ford; **M. C. Horine,** Mack; **J. H. Booth,** Thompson Products; **R. W. Roush,** Timken-Detroit Axle; **M. D. Gjerde,** Standard Oil (Indiana); **R A. Richardson,** GMC Research Laboratories; **W. G. Payne,** USN Engineering Experiment Station; **Lloyd Withrow,** GMC Research Laboratories; **C. F. Bachle,** Continental Aviation and Engineering; and **J. G. Moxey, Jr.,** Sun Oil.

* * * * *

SAE Journal readers who couldn't take in the meeting won't have to miss out on the meaty discussion at the eleven technical sessions, too, thanks to these secretaries: **Henry Jennings,** Fleet owner; **G. M. Buehrig,** Ford; **F. R. Nail,** Mack; **Mauri Rose,** Chevrolet; **C. T. Langley,** Timken-Detroit Axle; **M. L. Hamilton,** Sinclair Research Laboratories; **J. S. Collman,** GMC Research Laboratories; **A. R. Schrader,** USN Engineering Experiment Station; **H. A. Bigley, Jr.,** Gulf Research and Development; **J. C. Squiers,** Continental Aviation and Engineering; and **R. W. Donahue,** Sun Oil.

* * * * *

"Riding in some truck cabs is like being in a sentry box in an earthquake," observed **Maurice Olley,** of Chevrolet, at the Truck Riding Comfort round table.

* * * * *

Discusser **"K" Glynn** reported that when he told **Merrill Horine** it was necessary to go over the brakes on AT&T trucks with a fine tooth comb, Horine quipped: "But, 'K,' what possible use could you have for a fine tooth comb?"

* * * * *

And then there was the one about the fellow named Reilly who joined the Army to live the life of Schine.

* * * * *

Division, Union Oil Co. of California, "Fuel Economy with Multi-Grade Oils."

It's Still 300 F

Laboratory and road tests, comparing SAE 10W/30 with SAE 10W and SAE 30 oils containing no V.I. improvers, confirm that oil consumption depends primarily on oil viscosity measured at 300 F. . .

. . . **L. A. McReynolds, S. C. Britton,** and **H. T. Quigg,** Phillips Petroleum Co., "Consumption Characteristics of Multiple Viscosity Grade Motor Oils."

Shines on Short Hops

SAE 10W/30 motor oil gave an average 14% better gasoline mileage than SAE 30 oil in city-traffic passenger-car tests where each trip was 3½ miles.

Maximum improvement in gasoline mileage obtained with multigrade oils is achieved during the first few miles of operation from a cold start.

In all our tests, antiwear characteristics of SAE 10W/30 oil were found to be equal to or better than those of the reference oil—a heavy-duty product containing better-than-minimum MIL-0-2104 level of compounding. . .

. . . **J. A. Miller** and **L. M. Hartmann,** California Research Corp., "Multigrade Crankcase Lubricants."

Route to Better Oils

Better oils can best be achieved by concentrating attention on the performance requirements of the gasoline engines now in service and to be built . . . and by disregarding arbitrary classifications or specifications which impose undesirable limitations.

Published data indicate that viscosity has a measurable effect on engine wear and scuffing under boundary lubrication conditions. However, it appears to be a relatively small factor which can be far outweighed by the influence of selected additives. . .

. . . **Leonard Raymond,** Socony-Vacuum Oil Co. and **J. F. Socolofsky,** Socony-Vacuum Laboratories, "Designing New Performance into a Special Motor Oil."

Newborn "Pinwheel"

The Whirlfire engine can be conveniently considered as two mechanically independent components—the

gasifier or gas generator section and the power turbine-transmission section.

Gyroscopic effect has been minimized in the Whirlfire engines by designing the two turbines to rotate in opposite directions.

Lubrication requirements of the gas turbine do not appear very severe.

The entire power package for the Firebird, including transmission and final drives, weighs only 775 lb. This gives the powerplant and drive a weight-to-power ratio of about 2 lb per hp. . .

. . . **W. A. Turunen**, Research Laboratories Division, General Motors Corp., "Pinwheels or Pistons?"

Pinwheel "Cradle"

Wishbones, wheel spindle, and steering axis ball joints form the front suspension linkage of the Firebird.

Rear axle, single leaf springs, and balance beam form a subassembly that is fastened to the frame at three points.

Steering linkage is of the parallelogram type with two idler levers, a connecting link, and tie rods reaching to the steering arms.

Compared to the usual arrangement, the order of the parts in the wheel and brake assembly is reversed. Brake drum and backing plate are mounted outside of the wheel. The wheel disc is integral with the hub and only the rim is removable. . .

. . . **Robert Schilling**, Research Laboratories Division, General Motors Corp., "A Cradle for New Power."

Plastic "Blanket"

The Firebird has a complete, operable, load-carrying metal chassis. The plastic body panels provide the desired shape and carry the aerodynamic loads.

Firebird body panels are approximately 0.10 in. thick and compare favorably in overall rigidity with standard 0.035 in. gage steel panel.

Maximum lift of the Firebird amounts to 45% of its gross vehicle weight, thus it will not become airborne.

For maximum service accessibility, the body shell was divided into large, easily removed sections. . .

. . . **R. F. McLean**, Styling Section, General Motors Corp., "An Aerodynamic Design in Plastics."

Licking "Lock"

The fuel pump investigated in our studies did not take a full stroke when the vehicle was operated on fuel producing borderline vapor lock.

It would appear that if the total ca-

Around the Meeting . . .

T&M and T&B men at the meeting got a preview of side dishes they could squeeze in and around meaty technical sessions at the 1954 SAE T&M Meeting in Boston. The 1954 SAE T&M Meeting General Committee, headed by **Bob Gardner**, saw to that! Besides showing an enticing 10-min colored movie of what to see around "the home of the bean and the cod," the General Committee passed out sightseeing maps and guides of the **entire** New England region.

* * * * *

Serving as leaders of the afternoon Panel Discussions and Round Tables were:

P. J. Kent, Chrysler Corp.
D. J. Schrum, Studebaker Corp.
Fred Hague, Sun Oil Co.
T. C. Gleason, Chrysler Corp.
W. J. McCortney, Chrysler Corp.
V. D. Polhemus, General Motors Corp.
C. L. Hecker, The Oliver Corp.
A. W. Neumann, The Willett Co.
F. E. Sandberg, Ford Motor Co.
H. A. Murray, The Texas Co.
R. L. Stanley, Diesel Engine Manufacturers Association
Maurice Olley, Chevrolet Motor Division
G. W. Newton, Aro, Inc.

* * * * *

On hand to record the ideas exchanged at the afternoon Panel Discussions and Round Tables for reports in later issues of SAE Journal were:

W. F. Sherman, Automobile Manufacturers Association
J. C. Gordon, Gordon-Chapman Co.
Murray Simkins, "Commercial Car Journal"
J. T. Moren, Chrysler Corp.
J. M. Clark, Packard Motor Car Co.
David Apps, General Motors Corp.
F. J. Zielsdorf, The Oliver Corp.
Henry Jennings, "Fleet Owner"
C. T. Kope, Ford Motor Co.
Lt.-Col. L. F. Ayres, Air Research and Development Command
W. E. Meyer, The Pennsylvania State College
A. C. Mair, Chevrolet Motor Division
George Beiser Instrument Society of America

* * * * *

Carl Hecker, of Oliver Corp., and his colleagues on the manufacturing cost reduction round table received rave notices for the novel way they ran their session. They enacted what happens in a manufacturing company when management asks department heads to cut cost. The script was so intriguing and the performances of all so real, many in the jam-packed room urged a repeat showing of their production.

* * * * *

For the Ladies . . .

Fashion Show

Golf

Mrs. J. C. Kyle again took top honors in the women's golf competition

Dancing

Bridge Playing

pacity of the fuel pump could be used, vehicle performance on volatile fuels would be improved.

Pressure of the fuel above the diaphragm in the test pump must be lowered if its total mechanical capacity is to be used. . .

. . . **John D. Caplan** and **Robert E. Wilson,** Research Laboratories Division, General Motors Corp., "Characteristics of Fuel Pump Operation During Vapor Lock."

Postwar Vapor Lock

Postwar cars can handle more volatile fuels than prewar cars. They can also handle more volatile gasolines than are currently marketed.

Postwar cars are most prone to vapor lock during an acceleration following a "soak" period. If acceleration vapor lock difficulties could be alleviated, a greater portion of the benefits inherent in more volatile fuels could be achieved. . . . **R. E. Barnum, P. J. Clark,** and **J. P. Hamer,** Esso Laboratories, Standard Oil Development Co., "Vapor Locking Characteristics of Passenger Cars."

Carburetor Icing

Some engines are sensitive to fuel volatility, others are not. Sensitive engines show a considerable decrease in stalling tendency due to carburetor icing as fuel volatility is decreased.

Use of a fuel additive may offer a partial solution to the problem of carburetor icing.

A high fast idle speed tends to keep an engine from slowing down enough to stall and high throttle blade temperatures minimize the amount of ice formed. . . .

. . . **W. P. Dugan,** Sun Oil Co. and **H. A. Toulmin,** Ethyl Corp., "The Carburetor Icing Tendencies of Some Present Day Fuels and Engines."

Who Does the Repairing?

The decision as to whether a fleet operator should repair his equipment in his own shop or send it out should be based on continued scrutiny of cost figures. Fleet operators have had enough experience with both arrangements to know that there's no other simple answer to the question.

When the vehicle owner does his own work, he has a chance to find design faults and driver abuse and to correct these causes of trouble. An outside

shop is likely to go on happily repairing the trouble without attacking the cause.

It takes a specialist to get the best out of a special-purpose tool. In small shops, special tools are likely to be used by five or six mechanics—none of whom is a specialist. As a result, cutters grow dull and there's no one responsible for their care. If the shop doesn't use the special-purpose tool frequently it had better send the work out.

. . . Round Table on **Where and When Does It Pay to Send Certain Parts and Units to Outside Garages for Repair.**

Diesel Combustion Chambers

The molecules are gradually learning to follow the arrows marked on the drawings of diesel combustion chambers. The result is greatly improved volumetric efficiency. But we still need improvement in scavenging to better the quality of the charge.

One British automotive diesel builder put 95 combustion chamber designs to a total of 2000 trials—just in the course of developing one model.

Of the U. S. buses ordered in the past year, 92% were diesel powered.

. . . Round Table on **Combustion Chambers of Automotive Diesel Engines.**

Analog Simulates Suspension

The technology of passenger car suspensions has reached the point where engineers want to run many more tests than they have time for. So they are using an electronic analog computer at Battelle Memorial Institute to simulate the suspension under a wide variety of conditions.

The analogy isn't perfect enough to give the final answer, but it does narrow down the range of experimentation needed. The time and effort saved more than justifies the cost of building and operating the analog.

. . . Round Table on **Seating.**

Compressor Bleed

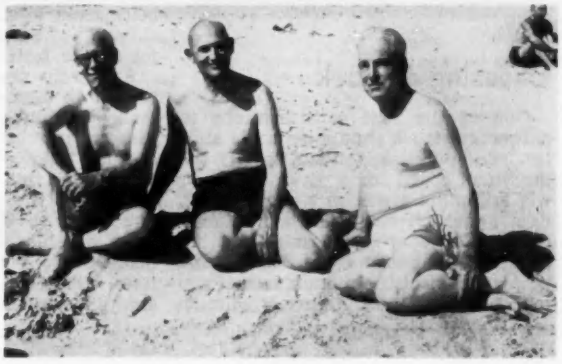
The main trouble with bleeding air from the compressor of a gas turbine powerplant to pressurize an aircraft cabin is that you introduce the possibility of oil contamination of the air.

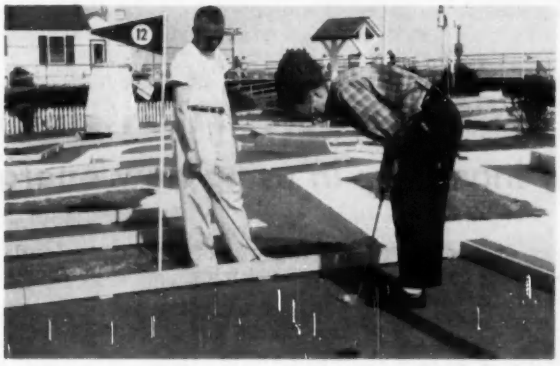
Not all engine manufacturers are experiencing this difficulty with their

For the Gentlemen . . .

Fishing

Sun Bathing





Golf

Surf

products. But all agree that absolutely no oil contamination can be tolerated.

The answer seems to be: (1) Take bleed air from as close to the centerline of the diffuser as possible to avoid picking up centrifuged oil vapor. (2) Mount lubricated accessories on the bottom of the engine so that oil won't drip into bleed passages. (3) Improve seals. (Balanced-pressure type seals have appeared quite successful, but there is evidence that shock waves may unload them, rendering them momentarily ineffective.)

If these moves don't end contamination, it may be wise to resort to a separate source of pressurization, such as an air turbine.

. . . Round Table on **The Problems of Compressor Bleed for Cabin Pressurization.**

Choosing a Truck

One of the first considerations in choosing a truck should be grade ability. The purchaser should specify the minimum speed for a given grade, or the minimum grade at a given speed, or a minimum speed and a minimum grade. (It's easy to determine whether a vehicle of known gross weight and power can meet these minimums if you use the SAE Truck Ability Prediction Procedure, which is SAE Special Publication SP-82.)

Some manufacturers consider that (1) a light truck should have the grade ability of a passenger car; (2) a bus should be able to climb a 4% grade at 25 mph, and (3) an over-the-road truck should be able to take a 3½–4% grade at 20 mph.

. . . Round Table on **What Are the Performance Characteristics Desired by the Operator, Covering Acceleration, Grade Ability and Roadability?**

Test Instrumentation

Every time you develop a better instrument, you uncover a new problem. Then you need a still better instrument to study the problem more closely. That seems to be the rule in jet engine testing instrumentation.

Relatively new hot-wire anemometers have disclosed little pockets of stalled air that rotate around the compressor annulus at about half rotor speed. They precede complete stall. To study this rotating stall more closely, engine developers would now like to have anemometers that are more durable, and give a more truly quantitative measure of stall amplitude. They would also like an "instantaneous" recording-camera speed change mechanism and an instrument to tell when stall frequency coincides with blade excitation frequency.

Hot-wire anemometers are being used also as fuel flowmeters. At first fuel turbulence at the wire obscured instantaneous flow fluctuations. But by using four pairs of wires stretched chordally across and bonded to the inner diameter of a double male AN fitting, instrumentation experts were able to average out the turbulence satisfactorily.

. . . Round Table on **Instrumentation Methods for Aircraft Jet Engine Testing.**

Car Air Conditioning

About 5 to 10% of all new cars purchased next year will have one thing in common—air conditioning. But there won't be much that's similar about the air conditioning installations in the different makes of cars. Cooled air, for example, will enter in at least three places (rear seat shelf, roof, and dashboard panel) . . . and units themselves will vary from self-contained package jobs to installations with some parts in the trunk, others under the hood.

. . . Panel discussion on **Automobile Air Conditioning.**

Recent Achievements . . . in automotive engineering.

Gains laid to ingenuity in using new energy forms.

IF a man from Mars dropped in on the Summer Meeting to survey current automotive achievements, his chief impression might be this: Automotive engineers harness a wide variety of energy forms and work them in unique ways.

The Martian scout's report would back up this observation with evidence on how:

- Chemical fuels burned in an internally whirling machine called a gas turbine have been made to propel an airborne device known as a helicopter.
- Similar fuels, squeezed until they explode in a contraption named after a Mr. Rudolph Diesel, recently have been adapted to a flying machine after years of operating land-bound vehicles.
- High-frequency sound waves are made to detect flaws in metal parts.
- Magnetic forces ferret out fine surface defects in automotive components.
- Invisible rays, called x-rays, give man eyes to see through heavy metallic pieces.
- Electrons can measure the relative hardness of metal.

In detailing his findings, the man from Mars would note that piston engines, used up to now in helicopters, suffer from premature failures. Components bringing on these difficulties (magnetos, connecting rods, valve mechanism, spark plugs, ignition harness, and carburetors) are completely eliminated in the gas turbine. Besides, this engine weighs about 250 lb, substantially less than a piston engine.

Originally developed by Turbomeca, in France, this powerplant is quieter, proves ideally accessible for maintenance, and performs well at altitude.

The gas turbine does have at least three disadvantages: (1) high fuel consumption under all operating conditions; (2) serious power loss in hot-weather operation; and (3) it requires extreme care at take-off power so as not to exceed maximum tail temperature.

Second item of interest in the Martian report would be the airborne diesel engine. It might read as follows: "Although not adapted to space travel, this peculiarly named propulsion device (called the Napier Nomad) can travel long distances in the earth's atmosphere. It consumes less fuel than the gasoline-burning variety. The British earthmen who developed it achieved their novel effect by combining a turbine with a piston engine.

"In terms of Earth's progress to date, the Napier Nomad is an efficient producer of power for its size and weight. Engineers who listened to a description of this engine felt its immediate future lies in transporting cargo. The military may be interested in it for reconnaissance . . . prolonged search periods at low altitudes and low speeds."

In his discourse on manufacturing technology, our visitor from outer space might focus on the variety of ways to test a part for defects without destroying or damaging it.

He would tell how radiations produce clear pictures on film of imperfections in parts made by welding, brazing, forging, rolling, drawing, and extrusion. And as an offshoot of researches into atomic energy, materials made artificially radioactive (called isotopes) can do the same job as x-rays. Such materials that look promising are Cobalt 60, Iridium 192, and Cesium 137.

The Press Found News Worth Printing

Newspaper and magazine men came to cover the Summer Meeting from New York, Detroit, Philadelphia, and other cities. They interviewed individual engineers on special topics as well as covered the technical sessions. Here David Wilkie, Associated Press, Detroit, and John Broderick of Automotive News, Detroit, interview Francis Davis on power steering problems

These radioactive isotopes look attractive for at least three reasons. First, no power source is required. The source is simply placed in a small cup for the duration of the exposure. Second, the set-up is extremely portable. And third, the materials can be put to work in areas inaccessible even to portable x-ray units. The source itself is small. Many are enclosed in capsules only ½-in. long by ¼-in. in diameter.

Another nondestructive testing technique he would have heard about is ultrasonic inspection. In this method, an ultrasonic pulse or vibration is passed through the part. The picture of this sound wave bouncing back through the part, onto a cathode ray tube, reveals discontinuities in the metal.

Ultrasonic inspection can detect the kinds of defects that won't show up by other inspection methods. And because the equipment is portable, it's attractive for quite a few inspection problems.

Magnetized iron particles and penetrating dies are being used in

Boardwalk Promenading Was a Popular Activity

Robert M. Wingerter won the men's golf championship at SAE Summer Meeting for the third successive year.

a wide variety of metal-working plants to show up surface cracks. And one manufacturer has found that you don't have to push a steel ball into metal to determine the material's hardness. He merely magnetizes each part, passes it through an electrical coil, and measures the amount of magnetism retained. That's an index of the metal's hardness.

The report to outer space would tell how all these methods are being installed in plants as normal processing operations. They are being mechanized, much the same as usual fabricating and assembly operations.

Perhaps as a final recommendation, the Martian visitor might suggest: "These novel inspection methods used on earth may be just what we need to work the bugs out of our new model flying saucers."

Following are highlights gleaned from papers, panel and round table discussions.

X-Rays Reveal Flaws

No one radiation source is satisfactory for all radiography. A source may actually have too great penetrating power.

Radiography cannot exhibit high sensitivity to laminar flaws, especially if they are "tight" or narrow or if they are unfavorably oriented with respect to the direction of the radiation.

Since metallurgical discontinuities of distinctly microscopic size and greatly varied orientation may occur in castings and welds, this is a promising field for radiographic testing.

The radiographic method is only of limited applicability for wrought materials. Most of the discontinuities that occur are either too small or too tightly closed for detection by this method. . .

. . . **James H. Bly**, X-Ray Incorporated, "Non-Destructive Testing by Radiography."

Flying Diesel

The Napier Nomad aircraft diesel engine weighs about 1 lb per hp and has a specific fuel consumption between 0.326 and 0.35 lb per ehp per hr over its operating range.

Unique performance of the Nomad is achieved with a "compound" engine, the operating cycle of which is devised so that each component can make its maximum contribution.

The engine is insensitive to increases

in ambient temperature, losing less than 2% of its take-off power for each 20 F increase in temperature.

It is in the civil field, particularly in air freighting, that the Nomad can make its biggest contribution to aviation. . .

. . . **Herbert Sammons** and **Ernest Chatterton**, D. Napier & Son Limited, "The Napier Nomad Aircraft Diesel Engine."

Production Control Tool

Many people do not realize the important applications for magnetic particle and penetrant inspection as production tools in process control.

In most cases where these methods are being used as production control tools, the savings are many times the inspection cost.

This equipment is capable of inspecting up to 2000 parts per hr, at costs down to less than a cent per piece. . .

. . . **Hamilton Migel**, Magnaflux Corp., "Magnetic Particle, Penetrant and Related Inspection Methods as Production Tools for Process Control."

'Copter Turbine Makes Good

The XT-51 fixed-shaft turbine has shown excellent compatibility with the rotor system in this helicopter. The simple isochronous governor control has provided an adequate constant speed device.

The free-shaft gas turbine has no apparent advantages as a helicopter powerplant when it is not desired to make use of take-off power in normal operation. . .

. . . **Ralph P. Alex**, Sikorsky Aircraft Division, United Aircraft Corp., "Helicopter Flight Experience with the Continental XT-51 Fixed Shaft Turbine."

Magnetism Tells Story

Magnetic retentivity is the basis of a new non-destructive method of checking the hardness of Arma steel rocker arms.

The electronic hardness tester is set up by using reference rocker arms previously selected for their hardness. A complete set of such rocker arms consists of a pair at the soft end of the range and a pair at the hard end of the range. One of each pair is 0.1 mm within the allowable range, the other is 0.1 mm out of the range. . .

. . . **M. J. Diamond**, Central Foundry Division, General Motors Corp., "Magnetic and Resistance Methods Used in Non-Destructive Testing."

Cooling Reefers

For mechanically refrigerated trucks and trailers, manufacturers now provide electric standby power sources. You can't afford to operate the 300-hp truck or tractor engine just for refrigeration.

A canvass curtain hung just inside the rear door of the refrigerated compartment helps keep the cold in and effects a big saving.

One trucker using dry ice to keep 2400 lb of hung beef at around 40 F on a 44-hr run finds he can do the job for 42¢ per hour.

. . . Round Table on **Operation and Maintenance of Refrigerated Vehicles.**

Interior Materials

Interior specialists have found that they can avoid the "cold" look of vinyl by giving it a dull finish and then embossing it to look like upholstery cloth. Most owners don't even notice that the plastic isn't cloth until they try to clean it—and then they love it.

Leather is actually a fabric of compacted, interlaced, almost-endless protein fibers. Tanning is the process of stabilizing these fibers so that they don't decay like meat fibers do. Tanners have made as much progress in the last few decades as they had in the previous few thousand years.

. . . Panel Discussion on **New Developments in Non-Metallic Materials.**

Sound Detects Defects

Ultrasonic inspection will not solve all problems, but it is capable of doing what other non-destructive methods cannot do.

It is capable of detecting minute interface defects, whereas x-ray techniques can only detect volume voids.

It permits detection of deep subsurface defects, something that the magnetic particle and liquid penetrant methods are incapable of doing.

. . . **Edward F. Weller, Jr.**, Research Laboratories Division, General Motors Corp., "ABC's of Ultrasonic Inspection."

Fault Detector

A demonstration of ultrasonic testing equipment developed by GMC's Research Laboratories Division was the frosting on the cake at the nondestructive testing session

Car Noise

The passenger compartment of an automobile is an acoustical chamber having a natural frequency of 55–60 cps. Any exciting frequency close to this level will give "body boom." The cure is to stiffen the axle housing to raise its frequency or to tune away the cavity from this natural frequency.

Making tire tread elements of slightly different lengths avoids generating a constant tire tone at steady speed and makes tire noise less noticeable.

. . . Round Table on **Noise Suppression in Passenger Cars.**

Sessions Enjoyed Good Audiences

The technical sessions were crowd pleasers judging by the turnout for technical papers all week

TECHNICAL COMMITTEE *Progress*

Revision Kit Issued For Aeronautical Drafting Manual

A NEW Revision Kit has been issued to bring the SAE Aeronautical Drafting Manual up to date.

Although a few of the 26 pages of the Kit contain minor modifications of existing material, most of the pages are entirely new. The new material covers:

1. Simplified way of dimensioning features such as holes and slots that are repeated on a part a number of times in a given pattern.

2. Discussion of checking practices, including a reference list of important items to be considered by the drawing checker.

3. Simplified method of drawing involute tooth form profiles.

4. List of dimensions and other data that S-1 recommends should be included on drawings of helical gears.

5. Delineation of V-type serrations of the following types: concentric, flat, external, internal, and face.

6. Methods of placing the surface roughness symbol on drawings. A chart showing the surface finishes that can be attained with common production methods is also included.

7. Recommendations for the dimensioning of flat springs and coned disc (Belleville) springs.

The Revision Kit is available from the SAE for $2. A copy of the complete manual (with these revisions included) is available for $4.50 loose; and $6.50 in a leatherette silver-printed binder.

This Kit was developed by Committee S-1, which also produced the complete Aeronautical Drafting Manual. Chairman of S-1 is Otto Kirchner of American Airlines.

Final details for the material included in the Kit were settled by S-1 when it met recently in Nashville, Tenn. After finishing their committee work, the group took time out one afternoon to visit the Arnold Engineering Development Center at Tullahoma. The accompanying picture shows the committee members as they posed near one of the huge wind tunnels.

After a tour of Arnold Engineering Center, members of S-1 pose in front of the 16-ft square test section of the huge supersonic wind tunnel now being constructed at the Center. This tunnel is designed for Mach numbers of 1.4-3.5. Full-scale powerplants—mostly turbojets and ramjets—will be tested installed in their airframes in this and its companion transonic tunnel. Each test section will be able to handle a configuration about 4 ft in diameter and 30 ft long

Members of the committee are (left to right): back row—H. F. von Goodat, Consolidated Vultee; J. A. Kabrud, Boeing; H. T. Dreyer, Continental Aviation; E. W. Egee, Westinghouse; O. E. Kirchner, American Airlines; C. H. Springer, University of Ill.; front row—M. L. Stoner, SAE; L. E. Trefney, Bendix; H. M. Favor, Aeroproducts; M. J. Church, United Air Lines; S. B. Elrod, Purdue; W. B. Billingham, Hamilton Standard; and G. Newton, Arnold Engineering Center

Correction . . . SAE Handbook

In Table 1 of the SAE Standard on Thermoplastic Insulated Braidless Low-Tension Lighting Cable, General Purpose (page 819 of the 1954 SAE Handbook) there is a mistake in the data for SAE Wire Size 20. The correct figures are: number of wires, 7; nominal size of strand, AWG 28 and 0.0126 in.; area of conductor, 1,119 circular mils; and maximum OD of finished cable, 0.095 in. The approximate diameter of the stranded conductor remains 0.040 in., and the nominal thickness of the insulated wall remains 0.023 in.

. . . SAE National Meetings

1954

August 16-18
National West Coast Meeting
Hotel Statler,
Los Angeles, Calif.

September 13-16
National Tractor Meeting & Production Forum
Hotel Schroeder,
Milwaukee, Wis.

October 5-9
National Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

October 18-20
National Transportation Meeting and Truck and Bus Engineering Display
The Sheraton-Plaza
Boston, Mass.

October 26-28
National Diesel Engine Meeting
Hotel Statler,
Cleveland, Ohio

November 4-5
National Fuels and Lubricants Meeting
The Mayo,
Tulsa, Okla.

1955

January 10-14
Golden Anniversary
Annual Meeting and Engineering Display
The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich.

March 1-3
Golden Anniversary
Passenger Car, Body and Materials Meeting
The Sheraton-Cadillac Hotel,
Detroit, Michigan

March 14-16
Golden Anniversary
Production Meeting and Forum
Netherland Plaza,
Cincinnati, Ohio

April 18-21
Golden Anniversary Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotel Statler and McAlpin Hotel, New York, N. Y.

September 12-15
Golden Anniversary
Tractor Meeting and Production Forum
Hotel Schroeder
Milwaukee, Wisconsin

June 12-17
Golden Anniversary
Summer Meeting
Chalfonte-Haddon Hall,
Atlantic City, N. J.

August 15-17
Golden Anniversary
West Coast Meeting
Hotel Multnomah
Portland, Oregon

Correction . . . Buckendale Lecture

The first L. Ray Buckendale Lecture will not be presented in August, 1954, as stated in the May issue of SAE Journal, page 92. Rather, it will be given in late Autumn of this year. (The exact date will be announced in a later issue).

The Winners!

The Designer . . .

"As an artist, I'm a rather average engineer." That's what William R. Power, first prize winner of the Golden Anniversary Emblem Contest, says of himself. About the closest he has ever come to art previous to his award-winning effort is doodling on a drafting board.

Power modestly observes that he didn't do it all himself. He feels that he received lots of help from several colleagues, also amateurs when it comes to art, at Cities Service in East Chicago, where Power is assistant chief chemist.

He first saw the contest announcement in the SAE Journal, and decided to take a crack at it. So he wiled away quite a few evening and week-end hours playing with lots of sketches. Finally he hit upon two which looked good to him and his adviser friends. He executed both and submitted them.

Power was confident that he had several pretty good pieces of art work. But he was still more than pleasantly surprised to receive the good news from M. A. Thorne, chairman of the SAE Public Relations Committee. "It's the first time I ever won a cash prize of this kind," said Power.

Up to now, Bill Power's latent drawing talent has been far overshadowed by his musical abilities. Gifted with a fine tenor voice that renders an Irish ballad as few can, Bill has sung at informal SAE gatherings, in a grand opera chorus, on radio, and as a church choir soloist.

Despite the new recognition given his artistic efforts, Power expects to remain knee-deep in the technology of petroleum products for a long time to come. At Cities Service, his present assignment keeps him busy with both customer technical service and research and development of new products.

Power has been an SAE member since 1951. He has been active on several CRC and ASTM committees. He is a graduate of chemical engineering from the Missouri School of Mines in chemical engineering, class of 1934.

WILLIAM R. POWER, assistant chief chemist, Cities Service Oil Co., was selected as first prize winner of the SAE Golden Anniversary Emblem Contest for his design, shown at right. He was presented with a check for $200 and a certificate at SAE Summer Meeting on Wednesday, June 9, by M. A. Thorne, chairman of the SAE Public Relations Committee.

The contest, sponsored and judged by SAE's Public Relations Committee, is the curtain-raiser for the extensive and interesting program SAE Council is developing to celebrate the 50th Anniversary of the Society in 1955.

The contest was designed to provide one vital ingredient of that program—an official SAE Golden Anniversary Emblem. The emblem will be used to dramatize and symbolize the idea behind the Society's 50th birthday. Plans are being made to use it on banners and programs, on stationery and in publications, on posters and in other ways throughout the Golden Anniversary program where its symbolism will meet a need.

The contest was open to all SAE members and to SAE enrolled students. More than 700 indicated by signed blanks that they wanted to enter the contest. One hundred and sixty six actual designs were received before the April 1 closing date and were considered in the judging by the Public Relations Committee. "There were many fine designs," reported Chairman Thorne, "The only hard part of our job was to decide on one winner from so many worthy competitors."

The final judging was done at an actual meeting of the Committee. It took several hours, even after the judges had gotten down to a relatively small group which we called "finalists."

The Committee came to a unanimous conclusion about the winner, and selected 10 others for honorable mention. To each of those who got honorable mention goes a certificate attesting the merit of their designs.

The Winning Emblem, worth $200 in first prize money to its designer, William R. Power, will embellish all phases of the Society's Golden Anniversary celebration during 1955. It will be reproduced in gold and blue wherever it will be reproduced in color.

Here are the honorable mentions:

R. M. Cherryholmes
Shell Oil Co.

F. P. Gilligan
Henry Souther Engineering Co.

J. Fred Krueck
Automotive Division
Thew Shovel Co.

Capt. Raymond W. Pecaut
Department of the Army

A. S. Randak
Sinclair Refining Co.

Carl F. Schory
Hamilton Standard Division
United Aircraft Corp.

A. D. Slatkin
Detroit Trim Plant
Ford Motor Co.

John A. Vitkovits
Southwest Research Institute

Lawrence J. Wierzbicki
Loyola University

Sumner L. Young
Associated Engineers, Inc.

The Presentation
M. A. Thorne, Chairman SAE Public Relations Committee, (right) presents certificate for the winning design to William R. Power

First Russell S. Springer Award

WITHIN the next six months, the first Russell S. Springer Award will be made to the youngest SAE member whose paper has been published in the 1954 SAE Transactions . . . And, every year thereafter, a similar award of $100 and a certificate will go to the youngest SAE member having a paper published in subsequent issues of SAE Transactions.

This new annual award by the Society of Automotive Engineers results from a bequest of $5000 made to the Society by the late Russell S. Springer, who died on July 1, 1953, at the age of 73.

Making the bequest, Mr. Springer had provided that the income from this $5000 "is to be used for annual awards, medals or engraved certificates for original and outstanding technical papers which are distinct contributions to the literature of the profession of automotive engineering" . . . and that "the prizes should be given for the encouragement of the younger members and for the development of the Society."

From this broad base, SAE Council developed the specific award to be known as the Russell S. Springer Award. Starting with this year, it is to be made annually by SAE "to the youngest SAE member whose paper is published in SAE Transactions in the year for which the award is made."

To insure uniform procedures in handling the award from year to year, the Council plans to apply the following rules:

1. The award shall be made only to an SAE member who was 33 years of age or younger at the time of presentation of the paper for which the award is made.
2. The following order of precedence shall be observed in selecting the recipient of the award each year from among those eligible under (1):
   a. First precedence goes to the youngest eligible author who is himself the sole author of a paper;
   b. Next precedence, in case no sole author is eligible in a particular year, goes to the youngest author who has only one coauthor.
   c. Authors of papers written by three or more coauthors shall not be considered eligible.
3. In case no author eligible under the requirements of (1) and (2) is available in a given year, no award shall be made in that year.
4. The first award shall be made in 1954—and subsequent awards shall be made annually as long as at least $125 of income continues to be derived from the Springer Fund.
5. Should the income from the Fund fall below $125 in any two years, SAE Council shall consider modification of the rules to bring the expense of the award in line with the income from the Fund.
6. The award shall be made and the recipient notified as soon as possible following publication of SAE Transactions each year.

Russell S. Springer, donor of the bequest which makes possible this new SAE award, had been a member of SAE for 31 years at the time of his death. When he applied for membership in 1922, he was vice-president and factory manager of the Holt Manufacturing Co. at Stockton, Calif., although Holt headquarters at that time were listed at Peoria.

Springer had retired from active business many years before his death, having given up active participation at about 50 years of age.

1954 SAE National West Coast Meeting

August 16-18 ***Hotel Statler***

Los Angeles, California

This meeting will tune in on the latest thinking of . . .

Commercial Vehicle Engineers — Fleet Operators

Petroleum Researchers — Diesel Engine Designers

Truck & Bus Engineers will . . .

- Evaluate Power Steering Systems
- Take a Fresh Look at Steering, Axle Design
- Discuss Current Transmission Developments

Fuels & Lubricants Specialists will . . .

- Analyze Multi-Grade Oils
- Report on Lube Field Testing
- Talk about Fuel Additives
- Re-examine Knock Concepts

Diesel Engine Designers will . . .

- Probe a New Fuel System
- Focus on Head and Gasket Problems
- Search Out Cylinder and Ring Wear Causes

Transportation Men will . . .

- Study Vehicle Road Test Results
- Compare Notes on Maintenance

The Dinner will feature two headline attractions

- A talk by SAE PRESIDENT WILLIAM LITTLEWOOD
- A dinner address on "What Are We Doing about Combustion?" by J. M. CAMPBELL, Chairman, Vehicle Combustion Products Committee of the Automobile Manufacturers Association

About SAE

GEORGE H. SCRAGG has announced that the George H. Scragg Organization, sales promotion service, is now located at 920 East 79th Street, Cleveland, Ohio. The firm was formerly located at 743 East 82nd Street, Cleveland.

Hess

Perelle

DONALD P. HESS, president of American Bosch Corp. since 1938, has been elevated to the post of chairman of the board of the company. **CHARLES W. PERELLE**, for the past five years president and general manager of ACF-Brill Motors Co., has been elected president and a director of both the parent corporation American Bosch, and the subsidiary Arma.

JOHN W. CARSON, quality control engineering representative for Continental Aviation & Engineering Corp.'s Manufacturing Division, has been appointed quality control manager of the company's Manufacturing and Research Divisions.

FRANK J. HAHN has been appointed assistant director of quality control for the Engine Division of the Fairchild Engine and Airplane Corp., Farmingdale, N. Y. He was previously chief inspector of the division.

JOHN F. HAINES has been appointed vice-president and chief engineer of the McCauley Industrial Corp., Dayton, Ohio. He has headed McCauley's design staff for the last two years. Formerly he was president of Haines Designed Products Corp. in Dayton.

Haines

Williams

SELDEN T. WILLIAMS, vice-president of Scovill Mfg. Co. and president and general manager of the company's A. Schrader's Son Division, has been elected president of the Brooklyn Chamber of Commerce, New York.

NATWAR M. PAREKH has joined Tata Locomotive & Engineering Co., Ltd., Jamshedpur, India, as superintendent of planning and progress. He was with Ford Motor Co. of India, Ltd., Bombay.

HOLDRIDGE WALDRON MARSH, formerly senior design engineer for Hupp Corp.'s Automotive Products Division, Detroit, is now with Amgears Inc. as a senior design engineer in the research and development department.

Robertson

Dybvig

D. D. ROBERTSON has been promoted to the post of director of sales for Dana Corp., Toledo, Ohio. Robertson was general sales manager for Dana. **CHARLES C. DYBVIG** succeeds Robertson as general sales manager. Dybvig was resident engineer for the Firestone Tire & Rubber Co., Detroit. He is chairman of the Membership Committee and a member of the Governing Board of SAE's Detroit Section.

RALPH J. RAYS is with the Ford Motor Co. as a project engineer in the advanced engine section of the engine engineering department. Previously, he was with the Detroit Diesel Engine Division, of General Motors as a layout engineer in the forward design section.

JOHN J. KADLEC, formerly assistant chief engineer of United Specialties Co., Chicago, has joined the Schield Bantam Co., Waverly, Iowa, as a project engineer.

FRED HEDEMANN, vice-president, operations, Oahu Transport Co., Ltd., Honolulu, has just completed Harvard University's advanced management program, 25th session. The 13-week course of discussion on management problems is a program for top management of all industries. Representatives from the U. S., as well as the rest of the world may attend. Hedemann, who is chairman of SAE's Hawaii Section, returned home late in May.

W. M. GILBRETH is now supervisor, product application, for Gulf Oil Corp., Philadelphia. He was staff engineer with Gulf in New York.

JOHN L. COLLYER, who had been chairman of the board, president and chief executive officer of The B. F. Goodrich Co. has relinquished the presidency and has been reelected chairman and chief executive officer.

Collyer

Dinsmore

RAY P. DINSMORE, vice-president in charge of research and development of the Goodyear Tire & Rubber Co., has been elected a term member of the M.I.T. Corp., governing body of the Massachusetts Institute of Technology. His selection was made by the M.I.T. Alumni Association and is for a five-year period, beginning July 1. Term membership of the M.I.T. Corp. is equivalent to trusteeship of a college or university.

Dinsmore is also president-elect of The American Institute of Chemists, New York. He will take office in May, 1956 and serve for two years.

Members . . .

HANSJOERG BENDEL is now chief sales engineer of the industrial vehicles department, Schweizerische Industrie-Gesellschaft, Neuhausen, Switzerland. He was assistant chief engineer in Westinghouse Brake & Signal Co.'s brake department, Berne, Switzerland.

GERALD REINSMITH is now factory manager for Narmco Metlbond Co., Chino, Calif., manufacturer of Multiwave formable aluminum core and fabricators of bonded metal parts. He was formerly Washington, D. C. office manager for Narmco Industries.

R. H. YEAKEY, formerly assistant research engineer, road test, for the Southwest Research Institute, San Antonio, is now project engineer for the Institute.

ERNEST A. WEIL has joined the Wright Aeronautical Division of Curtiss-Wright Corp., Wood-Ridge, N. J. as a senior engineer in the experimental department. He was a project engineer for the Ethyl Corp., Detroit.

Vesper

Reeves

HOWARD G. VESPER, vice-president of Standard Oil Co. of California, is the new president of the Industrial Research Institute, Inc. Vesper is also president of Standard's subsidiary, the California Research Corp. **E. D. REEVES,** executive vice-president of Standard Oil Development Co., New York, has been elected vice-president of the Institute, succeeding Vesper. Reeves automatically succeeds to the presidency in 1955.

JOHN W. BORGQUIST has joined the City of Santa Maria's (Calif.) engineering department as chief engineering draftsman. Formerly he was plant engineer for Sinton and Brown Co.

JOHN H. FAUNCE is a sales engineer for Cummins Engine Co., Columbus, Ind. He was manager of Blackwood Hodge Pty., Ltd., Melbourne, Australia.

d'Arcamble

Deeds

ALEXANDER H. d'ARCAMBAL has been elected president of Niles-Bement-Pond Co., West Hartford, Conn. He was vice-president and acting general manager. **CHARLES W. DEEDS,** former president of the company from 1943 to 1947, has been elected chairman of the board of directors. Niles-Bement-Pond includes Pratt & Whitney Machine Tools Division, Pratt & Whitney Cutting Tool and Gage Division, Chandler-Evans Division, and The Potter & Johnston Co. of Pawtucket, Rhode Island, a subsidiary.

EDMUND CARL SEDLACK is administrative assistant to the manager of the Aviation Gas Turbine Division of Westinghouse Electric Corp., Kansas City, Mo. Prior to joining Westinghouse, Sedlack was an aviation engineer for the Studebaker Corp., South Bend, Ind.

E. RICHARD COOPER, formerly liaison and project engineer on fuel pumps for Hydro-Aire, Inc., Burbank, Calif., is now sales engineer representing products and engineering talent of Bendix Aviation's Pacific Division, North Hollywood, Calif.

R. J. WILCOX has been named executive technical director of a new metallurgical x-ray service of the Michigan Steel Casting Co., Detroit. Wilcox is technical director of the company. He is also chairman of SAE's Iron & Steel Technical Committee Division XXII—precision castings.

Wilcox

McGinn

HOWARD J. McGINN, president of Eaton Mfg. Co. has announced the creation of a new division to be known as the Aircraft Division. Located in Battle Creek, Mich., this organization will occupy offices and manufacturing areas adjacent to the present Valve Division. McGinn says the rapidly expanding jet aircraft industry, with increasingly heavy demands on Eaton for the production of jet engine blades, has made this move necessary.

CHARLES C. COZZENS, staff engineer at Air Associates, Inc., Teterboro, N. J., has been named sales engineer for the company. Assigned to Air Associates' Dallas branch, Cozzens will represent the company's Aircraft Products Division and Electronic Equipment Division in serving the aircraft industry in the Southwest. He will also investigate and develop commercial applications for the company's products in the process industries in that area.

THOMAS H. WICKENDEN has become a consultant on special projects for International Nickel Co., following his retirement as vice-president and manager of the company's Development and Research Division.

Wickenden

McGuire

R. C. McGUIRE has become assistant to the vice-president of engineering, Eastern Air Lines, New York. He was development engineer, structures and systems, American Airlines, New York.

Award Given to Hurley

ROY T. HURLEY (left), president of Curtiss-Wright Corp., is shown receiving the first International Aviation Trade Show Award. The plaque is being presented by Eugene P. Connolly, president of Aircraft Trade Shows, Inc., sponsors of the exhibition and the award. The plaque reads, "Awarded to Roy T. Hurley for his patriotic efforts to create a stronger aircraft industry in the interests of national defense, air commerce and a free world."

RALPH I. BOST has been appointed chief engineer of the Autostarting Division of Gould-National Batteries, Inc., St. Paul, Minn. He will make his headquarters at the company's laboratory at Depew, N. Y., and will be under the direction of the vice-president in charge of engineering. He will have charge of automotive research, engineering, and development. He was special engineer in the division which he will now head.

Bost

Conner

RAY C. CONNER has been named to head the new automotive products sales group of Vickers, Inc., a division of the Sperry Corp., Detroit. Until recently he has been on special assignment for mobile sales applications in the sales department.

A. H. SCHMAL has been appointed chief engineer of the Detroit Gear Division of Borg-Warner Corp., Chicago. Prior to joining the staff at Detroit Gear, Schmal was executive engineer for Mack Mfg. Co., Plainfield, N. J.

Schmal

Flynn

ROLAND W. FLYNN, supervisor, product application, of Gulf Oil Corp.'s New York Sales Division has received a diamond-studded pin and engraved certificate in recognition of his 20-years of service with Gulf.

EARLE W. GARD is now owner of the Earle W. Gard Consulting Service, Los Angeles. He is a consultant for petroleum and chemical industries. Gard was formerly vice-president of The Ralph M. Parsons Co., Los Angeles.

J. C. PATERSON has been appointed branch manager for International Harvester Co.'s Motor Truck Division at Salt Lake City, Utah. He was a sales representative for International Harvester.

LOUIS W. SHANK has been promoted to suggestion system manager for Ethyl Corp., New York. Shank was assistant to the vice-president, sales, at Ethyl.

WILLIAM L. MITCHELL has become director of GMC's styling section, Detroit. He was assistant director of styling.

JOHN C. GUENTHER is now acting director of technical information for Chrysler Corp.'s Engineering Division, Detroit. He was previously with the public relations department of Chrysler.

MICHAEL O. JONES has become assistant to the general superintendent, Manufacturing Division, Ford Motor Co. of Australia. He will handle special assignments. Jones was facilities engineer of the Overseas Operations Division of the Ford Motor Co. of Canada in Windsor, Ontario.

GEORGE J. REED is assistant product engineer, Philco Corp., Philadelphia. He was process engineer for GMC's Fisher Body Division at Grand Rapids, Mich.

ABRAHAM TUCKER, previously design engineer in the transmission group of Bell Aircraft Corp., Fort Worth, is now design engineer for Solar Aircraft Co., San Diego.

ROBERT E. CLARK, previously resident engineer at the New Orleans tank engine plant of Chrysler Corp., is now with Chrysler in Detroit as staff engineer.

DONALD M. HESLING, director of manufacturing and engineering, Sealed Power Corp., Muskegon, Mich., is now vice-president in charge of engineering and manufacturing.

Hesling

Weger

JOHN JOSEPH WEGER has become industrial development engineer for the Kingsbury Ordnance Plant of the American Safety Razor Corp., La Porte, Indiana. Weger was senior facilities engineer for Kaiser Motors Corp., Dowagiac, Mich.

SEYMOUR J. CHENEY is a torque converter engineer for Clark Equipment Co.'s Transmission Division, Jackson, Mich. He was with W. H. Rambo Co., Portland, Oregon, consulting plant engineers.

WILLIAM BENDER EDMISTON, formerly project engineer for Kaiser Motors, is now development support engineer for Boeing Aircraft Co., Seattle.

ROBERT W. KINNEY, previously assistant contracts administrator for A. V. Roe, Canada, Ltd., Malton, Ontario, is armed services sales engineer for Curtiss-Wright Corp., Wright Aeronautical Division, Wood-Ridge, N. J. Kinney was a vice chairman of the Aircraft Activity in '51–'52 and '52–'53.

JACK D. MATTHEWS has become assistant project engineer for the Holley Carburetor Co., Van Dyke, Mich. He was previously chief test engineer, Continental Motors Corp., Research and Development Division #2, Detroit.

Herreshoff Retires from Chrysler

A. G. HERRESHOFF has retired as executive engineer in charge of development design after more than 27 years with the Chrysler Corp. He joined Chrysler in 1927 as an engine designer, following 16 years experience in development and design work with a number of shipbuilding and automotive concerns, including the Consolidated Ship Building Co., Mack Truck Corp., and the Fifth Avenue Coach Co.

Evidences of Herreshoff's design work are now found throughout the automotive, marine and aviation worlds. Among the pioneering ventures to which he contributed are the original Bulldog Mack truck, the first of the modern Fifth Avenue coaches and the earliest lines of Chrysler-built Fargo trucks and buses.

In 1942 he was invited by the British Government to visit England as one of eight aeronautical experts representing American industry. The purpose of this mission was to inspect British aircraft designs and production methods and discuss American developments in these fields.

Herreshoff comes from one of America's most famous families of yacht designers and builders, and has produced notable designs in both sailing and powered craft.

The following SAE members were speakers at the fourth session of The Industrial Council, sponsored by Rensselaer Polytechnic Institute, Troy, N. Y., May 14–15: **GEORGE W. MASON,** president and chairman of the board, American Motors Corp.; **VOLLMER W. FRIES,** vice-president, The White Motor Co.; **CLAY P. BEDFORD,** president Chase Aircraft Co., Inc.; **P. C. ACKERMAN,** executive engineer-laboratories, Engineering Division, Chrysler Corp.; **WALLACE S. BERRY,** chief mechanical engineer, American Motors Corp.; **JOHN M. CAMPBELL,** assistant technical director, general manager's staff, General Motors Research Laboratories Division; **ROBERT CASS,** assistant to the president, The White Motor Co.; **CHARLES A. CHAYNE,** vice-president in charge of engineering, General Motors; **JOHN F. GORDON,** vice-president, director and group executive in charge of body and assembly plants, General Motors; **HERBERT L. MISCH,** staff engineer, Packard Motor Car Co.; **W. D. REESE,** engineering manager, Motor Truck Division, International Harvester Co.; **WILLIAM H. TAYLOR, JR.,** director of purchasing, Packard Motor Car Co.; **PAUL E. TOBIN,** regional manager, New York City, The White Motor Co.

The Industrial Council, sponsored by R.P.I., is supported by industry. In its forums, conducted semiannually, it deals with major social and economic phases. Its aim is to establish better cooperation between industry and education for a stronger and unified nation. This session was for a careful study of the impact of the industry on today's world. Previous meetings have concerned petroleum, chemical, and electrical manufacturing industries.

W. F. SCHREIBER has been named chief draftsman of the Ford Tractor and Implement Division, Birmingham, Mich. Schreiber was previously chief draftsman with the Hoffman Motor Developments Co. of Detroit.

JAMES PAUL McSWEENEY has become requisition engineer in the motor engineering department of the General Electric Co., Erie, Pa. He was supervisor of GE's service engineer pool for the American Locomotive Co., Schenectady, N. Y.

PAUL G. ANDERSON, formerly service manager for Coleman Motors Corp., Littleton, Colo., is now with the Shell Oil Co., Denver, as automotive engineer, Denver area office.

JACK D. MATTHEWS has joined Holley Carburetor Co., Van Dyke, Mich., as assistant project engineer. Matthews was with Continental Motors Corp. as chief test engineer in the Research and Development Division, Detroit.

D. A. BROWN, West Texas Division manager for A.R.A. Mfg. Co., Fort Worth, will add to his duties the supervision of A.R.A.'s new sales and service centers at Lubbock and Odessa, Texas. For the past several years Brown has been associated with Orand Buick Co., Dallas, as assistant service manager. A.R.A. produces the Refrigair line of automotive air conditioners.

P. J. T. RAWLINS has been appointed chief engineer of Oren Roanoke Corp., Roanoke, Va. He was chief engineer, Corbitt Co., Henderson, N. C.

RICHARD FRANK BURRIS is with the Pacific Intermountain Express Co., Denver, as an automotive engineer. Burris was with the Bedford Garage Service Division of Safeway Stores, San Francisco as a maintenance consultant.

ROBERT P. ZUNDEL is now a test engineer "A" for the Automatic Transmission Division of Ford Motor Co., Livonia, Mich. He was formerly product test engineer "B" for Ford's Aircraft Engine Division, Chicago.

EMORY NEWTON YOUNT has joined North American Aviation at Downey, Calif. He is a research engineer. Yount was with Ford in Dearborn, Mich., as a research engineer "B".

CHARLES WILLIAM ELDER has become manager of the fleet sales department of Ford Motor Co.'s Oklahoma City district. He was a product engineer in the truck sales department for Ford at Dearborn, Mich.

JOHN THEODORE BENEDICT is now engineering editor of "Automotive News". He was an executive editor of "Design News" and "Purchasing News" at Rogers Publishing Co., Detroit.

CHARLES S. MILLER has joined the Liquidometer Corp., New York, as a design engineer. He was a designer for Sperry Gyroscope, New York.

ALBERT HEALEY has retired as director of production, Dunlop Rubber Co., Ltd., London. He is maintaining his work with various bodies, such as the British Institute of Management.

R. C. TESCH is with Halladay Motors, Inc., Cheyenne, Wyo., as service manager. He was parts and service manager for Meier Truck Sales, Inc., Madison, Wis.

JOHN F. PRICE, previously district manager for Twin Disc Clutch Co., Newark, N. J., has joined the special sales department of Watson-Flagg Corp., Patterson, N. J.

RAY L. KUZMA has joined Ford Motor Co. as a project engineer in the advanced engine section of the engineering department. Prior to joining Ford, he was with the Detroit Diesel Engine Division of GMC as a junior designer.

RALPH E. LAMBRECHT is on a two-year leave of absence from Johnson Motors, Division of Outboard Marine and Mfg. Co., Waukegan, Ill., while he serves with the U. S. Army. Lambrecht was a project engineer at Johnson.

S. UNTERMYER, formerly senior engineer at the Argonne National Laboratory, operated by the University of Chicago, is now with General Electric Co., Schenectady, N. Y.

WILLIAM N. BLATT is now employed by the AiResearch Mfg. Co. as a preliminary design engineer. He is doing analytical work in the power turbine group. He was research engineer for Shell Oil Co., Wood River, Ill.

DAVID B. FIELD has been called to active duty with the Army. He will be on military leave of absence from the Detroit Diesel Engine Division of GMC.

HENRY W. HOLMES, formerly superintendent of maintenance for Ryder Truck Rental System, Miami, is now superintendent of equipment and maintenance for the Dixie Ohio Express Co., Cincinnati.

ROBERT E. ALLAN is with the Fisher Body Division of General Motors, Detroit, as engineer-in-charge, development group. Allan was formerly chief engineer for the Silver Eagle Co., Portland, Oregon.

ORVILLE CRAIG FAY has joined the Dodge Division of Chrysler Corp., Detroit, as contact engineer-resident electrical engineer. Fay was previously assistant to the vice-president of sales, The Pierce Governor Co., Inc., Anderson, Ind.

CHARLES W. KYNOCH has become executive engineer, automotive and transportation engineering, for Wetmore Hodges and Associates, Inc., Redwood City, Calif. He was chief engineer at the Detroit Arsenal, Ordnance Corps, U. S. Army, Centerline, Mich.

Obituaries

LEROY V. CRAM

Leroy V. Cram, ex-General Motors automotive engineer, died April 26. He was 70.

Cram had been with GMC for more than 40 years. He joined the company in the employ of the Oakland Motor Co. in Pontiac, Mich., in 1908. When he retired in 1949, he was chief consultant of war products of the Detroit Diesel Division.

Between that time, he left Oakland to go to Flint, Mich., with the Buick Motor Co., in whose employ he remained until 1913. From this time until he joined the Chevrolet Division in 1922 he held various positions with numerous automotive companies. Among these were: production engineer and factory manager of the Empire Automobile Co. in Indianapolis; with the Government as production engineer on the Liberty motor; and production engineer of the Mercer Motor Co., Trenton, N. J.; after which he joined Chevrolet, as resident engineer in Flint.

Later he joined the Allison Division at Indianapolis as production engineer. In July of '43 he was asked to take a special assignment at the Detroit Diesel Engine Division.

A member of SAE for forty-three years, he was vice-president representing the Production Activity in 1945. Among his other memberships were the Engineering Society of Detroit, Sigma Xi engineering fraternity, the American Society of Metals, the Red Run Golf Club, the Oakland Hills Country Club, the Elks, and Rotary.

Born in Marseilles, Ill., he attended high school there and then went to Washington University in St. Louis. He received his B.S. degree in electrical engineering in 1904.

JOHN JOSEPH WYDLER

John Joseph Wydler, 67, analytical engineer for National Supply Co., Springfield, Ohio, died suddenly May 19.

Well-known for his thesis, "Torsional Vibrations in Piston Engines and Methods for Determining their Graphical Analysis," Dr. Wydler was also the holder of 11 patents. He devised a method for supercharging internal combustion engines almost 300 per cent.

He was born in Munich and received his baccalaureate magna cum laude from the University of Munich. In 1920 he received his doctorate in engineering (also magna cum laude) from the same University.

He came to the U. S. in 1926 and was employed by the Cities Service Co. to develop his supercharging theories. In '41 he joined the National Supply Co. and for the past 13 years was a resident of Springfield.

GEORGE E. MARTIN

George E. Martin, retired brake engineer for GMC's Research Division, Detroit, died from a heart attack, April 19. He was 75.

Before joining General Motors, Martin had design and factory experience on both pleasure cars and trucks. He also worked on motors, chassis layouts and construction. He had been chief engineer for Diamond T Motor Car Co., designer and estimator for the Illinois Steel Co., a detailer for the City of Chicago, and at one time had been with Green Engineering Co., Chicago, doing stock and cost work.

A native of Croghan, New York, he attended the Michigan Agricultural College where he received his B.S. degree.

Martin was a member of SAE for 37 years.

S. FRANK BAKER

S. Frank Baker, president and general manager of Detroit Automotive Products Corp., died May 17. He was 58.

Baker was a graduate of the School of Military Aeronautics, University of Texas. This was a school set up for special training during World War I. After he graduated, he was commissioned with an RMA rating at Ellington Field, Texas, early in 1918.

Later he was ordered to Selfridge Field as an assistant chief instructor and eventually became an engineering and test officer for the rebuilding of motors and planes.

Following his discharge from the service, Baker designed a commercial three-place plane with several other men. It was built under Baker's supervision and successfully flown sometime later.

In 1932 he became interested in patents involving the Thorton four-rear-wheel drive for trucks. He contributed several engineering features to the design of the Thornton drive, one of which was patented. This had to do with an unusual type of oil seal necessary to prevent the transfer of oil from one driving axle, through the inter-axle gear case, to the other driving axle.

He was also one of the organizers of Patent Developers, Inc., a patent holding and development company.

from the Sections

Washington

Field Editor
C. Janeway
May 18

A "CONVERTED BATHTUB WITH BOUDOIR ACCESSORIES" is the way Alexander E. Ulmann described the modern American car. Ulmann is a past-president of the Veteran Motor Car Club of America and a member of the Sports Car Club of America.

"The entire automobile industry is simply trying to develop comfort and add chrome to reach **the woman buyer,"** he said. Ulmann seemed to believe that improvements in sports cars are not being applied to conventional autos. He also thought that **European cars are ahead** of American autos in many respects.

The meeting included a **sports car display,** a movie of the sport car event at the Le Mans Race, and a fashion show for the ladies present.

New England

Field Editor
E. F. Donahue
May 4

IN THE NEAR FUTURE transcontinental shipments from the producer to consumer will take place in a matter of hours. Airport freight terminals with their costly equipment and high overhead may soon be a thing of the past. Walter Tydon, chief engineer of Fairchild Aircraft, revealed these **exciting possibilities** to this Section as he presented a paper and a short motion picture on the Fairchild XC-120 pack-plane and its cargo packs.

Three types of **cargo packs** have been used to date: the pallet, all-purpose, and the roadable-pack. It is the roadable-pack which is to be watched very closely by shippers and producers because it may hold the answer to the transportation industry's need for higher speeds in transit. It should make shipment of perishable goods more profitable.

Originally designed for military service, the pack-plane with its detachable and roadable pack is now undergoing further study at Fairchild. Fairchild's intention is to produce a unit which can place air freight in the **"wholesale" shipping market.**

Texas Gulf Coast

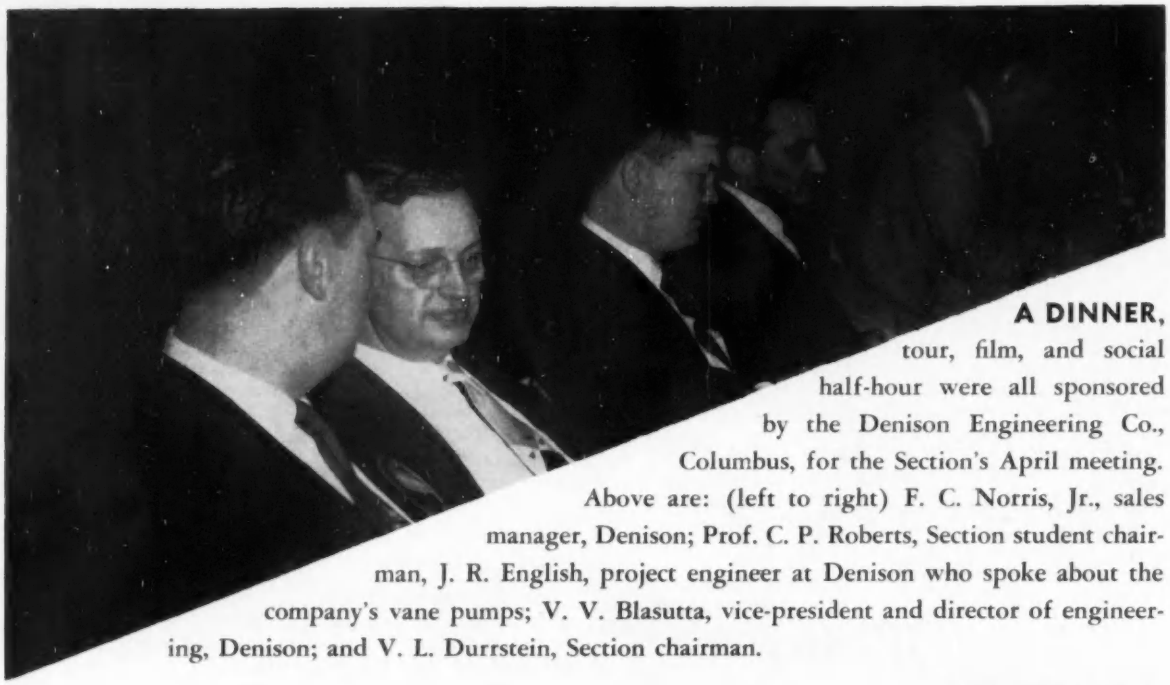
Field Editor
W. B. Tilden
Feb. 12

A NEW TYPE OF FUEL PUMP with advanced design features is being tested by the Cummins Diesel Engine Co. The new pump, called the PT, **weighs only 11 lbs** and has 182 parts. This was revealed by George Stevens, Fort Worth regional manager for Cummins.

According to Stevens, the new pump does not have to be timed to the engine, and it eliminates the limitations of engine rpm. The advanced design pump maintains pressure to all injectors for **all**

From Section Cameras

Dayton April 15



A DINNER, tour, film, and social half-hour were all sponsored by the Denison Engineering Co., Columbus, for the Section's April meeting. Above are: (left to right) F. C. Norris, Jr., sales manager, Denison; Prof. C. P. Roberts, Section student chairman, J. R. English, project engineer at Denison who spoke about the company's vane pumps; V. V. Blasutta, vice-president and director of engineering, Denison; and V. L. Durrstein, Section chairman.

St. Louis May 11

A PIG IN A BLANKET is presented to N. Eckerly (left) as a door prize at the Section's last meeting of the season. Gene Kropf, originator of the bank idea, is shown making the presentation. The pig had been well-nourished with pennies throughout the year.

speeds and loads. In the case of multi-engine units, it will balance the load on all engines as all the fuel systems are tied together.

He said the Cummins fuel system preheats and **preconditions the fuel** before it gets to the combustion chamber. Other advantages of the fuel system are:

1. The pump does not have to be primed.
2. Pump capacity is such that **five times more** fuel is circulated to the injectors than is needed.
3. There are no ball check valves in the injectors as the plunger, in this case, acts as **its own check valve.**

Stevens said there are about 400 PT fuel systems now in operation, on test, in road vehicles for a total of 2,000,000 miles. Results are very satisfactory.

May 14

A SPORTS CAR DISPLAY was part of the meeting held in May. The display included the Austin-Healey 100, Cunningham, Jaguar XK-120 convertible, Mercedes-Benz 300's coupe, Porsche, and the Ratio Sports Car "Venus." Also on exhibit was a small plastic model of the Ford "Thunderbird" and **a photographic show** of other interesting sports cars.

Mel Martin, feature columnist for the "Houston Post," gave a talk, "American and European Sports Cars." He traced the history of **early cars and races.**

Some interesting comparisons of present day conventional autos with sports cars was also made by Martin. In comparing weight (lb) to power ratio: the Cadillac is 18.4/hp, the Jaguar 17.1/hp; Chrysler 17.3/hp, Ferrari 6.2/hp. Top speed of the Cadillac is 114 mph as compared to the Jaguar at 126 mph, the Chrysler 112 mph, the Ferrari at 185 mph or the Mercedes at 160 mph.

Syracuse

Field Editor
D. L. Kidd

May 21

THE COMING YEARS will bring commercial air transports that fly higher, faster, farther, and will carry people and goods with greater safety, comfort, **convenience, and economy.** That's what SAE President William Littlewood told more than 50 members and guests at a dinner meeting in Elmira.

He said that commercial transports probably will attain a **top speed** of Mach 0.85. No faster-than-sound transports now are contemplated. Breaking through the sound barrier would penalize comfort, safety, and economics.

Littlewood noted that from 1903 to 1953, speeds increased from 7 to 8 mph annually in commercial aviation. Military aircraft increased their speeds 14 mph per year over the same period.

Of the current crop of gas turbines, **the bypass engine** looks most promising to the airlines. The pure jet engine has the disadvantages of low fuel economy and noise. The turboprop is a complex machine. The bypass turbine promises better fuel economy, low-speed efficiency, and good flexibility.

Right now the **Rolls Royce Conway** is the only known bypass turbine. Littlewood believes there will soon be at least one, and perhaps more, aggressive bypass turbine programs under way in this country.

Future jet transports, predicted Littlewood, will fly at altitudes of 45,000 to 50,000 ft. There they will be able to top any weather.

Mid-Michigan

Field Editor
C. A. McKinney

May 10

THE LADIES MUST BE CONSIDERED when a stylist brings out a new car. Damon Woods of Ford Motor Co.'s styling section brought this out at the final Section meeting of the season—Mid-Michigan's first "Ladies Night." Woods gave a complete and interesting description of **the stylist's problems.** From the enthusiastic response, "Ladies Night" may become an annual event.

Metropolitan

Field Editor
L. Peat

May 6

A NEW REINFORCED PLASTIC DELIVERY TRUCK BODY weighs only 650 lb. Trucks of this type will be used by United Parcel Service, a delivery service organization which serves department stores from coast to coast.

James S. Lunn, president of Lunn Laminates, Inc., and Harry T. Douglas, vice-president of Lunn, told members about **production methods** used in manufacturing the lustrous, brown-colored plastic bodies. Lunn Laminates was the developer of Chevrolet's Corvette sports car body parts under a prime contract.

The new delivery truck **body has 19 parts,** gas tank included, and is mounted on a one-ton chassis. Though the original body was made by the contact press molding process, when commercial output of the body starts, **vacuum bag molding** will be used. Lunn technicians believe this method results in more flexibility of design, superior strength-weight ratio, and lower production cost.

Weighing only 650 lb, as compared to 1,700 lb of the aluminum-steel type, the plastic body is ex-

From Section Cameras

LADIES MUST BE CONSIDERED, according to Damon Woods, when a stylist brings out a new car. Woods, who is with Ford Motor Co.'s styling section, was speaker at the Section's first "Ladies Night."

PRESENTING a past-chairman's certificate to Edward Holtzkemper (right) is Robert Hirchert, vice-chairman and secretary of the Section.

FOR LEADERSHIP of the Mid-Michigan Section when it operated as a Group under the sponsorship of Detroit Section, Earl Wilson (left), E. J. Godin (center) and John R. Emerson (right) received past-chairman certificates. Wilson was chairman from 1945-'48, Godin '48-'49, and Emerson '49-'50.

pected to reduce **maintenance and purchase costs.** It will also cut gasoline consumption and promote longer tire life.

The only metal used in the truck, in addition to the steel connecting chassis bolts, is in the chrome handles on the **sliding doors.** Major parts of the body are formed by one and two-ounce mats of Owens-Corning Fiberglas impregnated with **polyester resins.**

Another outstanding feature is the overhead disappearing package door which opens and shuts with the flick of a finger. Lunn also claims that color will last as long as the truck body continues in service. There will be **no peeling or warping** because vacuum bag molding makes a colorant an integral part of the molded piece.

Field Editor
W. J. O'Donnell
May 17

"STABILITY AND CONTROL OF SUPERSONIC AIRCRAFT," was the subject at the May closed panel-discussion.

Dr. H. G. Stever, associate professor of aeronautical engineering at M.I.T., was chairman. Dr. Stever opened the meeting with a general statement of the problem in which he described the differences in static stability between **subsonic, transonic, and supersonic** flight regimes. He also covered the need for dynamic damping, the problem of sensitivity of the controls, pilot relief feature of an **automatic pilot,** and the problems and advantages of fully automatic flight.

J. Urbanik followed with a description of the problems of stability and control of aircraft, with particular reference to the interrelationship between the airframe design and the **manual control system.** He is systems engineer at Republic Aviation.

Dr. C. Herwald, engineering manager of the Air-Arm Division of Westinghouse Electric, presented the need for damping systems and their ultimate goal.

Other speakers were: R. S. Brannin, engineering section head for development of flight control, Sperry Gyroscope; R. Bretoi, research engineer, Minneapolis-Honeywell; W. B. Johnson, staff engineer, Lear, Inc.; C. Rafferty, analysis staff engineer, Eclipse-Pioneer Division of Bendix Aviation; H. W. Taylor, requisition engineer, General Electric.

Field Editor
Leslie Peat
May 21

MOST SUCCESSFUL POSTWAR OUTING of Metropolitan Section was held on May 21 at the Knollwood Country Club in Westchester when more than 100 members and their guests turned out for an all-day golf-games dinner and **dance program.** This was planned by Charles E. Chambliss, Jr., and his committee.

Rain failed to dampen the spirits of the group. Heartier members ignored the elements and took to the golf course.

A feature of the indoor entertainment was a veteran **car guessing contest** in which scale models, made by Past-Chairman Merrill C. Horine, were displayed to tax recollections of contestants.

Following the dinner, a past-chairman's certificate was presented to retiring Chairman Neil P. Flynn by Theodore L. Preble. Preble is also a past-chairman and a former vice-president of the SAE.

Cincinnati

Field Editor
E. B. Lohaus
May 24

"THE MAGIC BARREL," presented by Ohio Standard Oil's Harrold Goodnight, amused and amazed members at the May meeting. Goodnight is industrial engineer, sales, at Standard. The paper was an Oil Industry Information Committee presentation.

Visual proof was furnished by Goodnight of just a few of the many items made with the help of petrochemicals. These items include nylon, dacron, polyethelene, vinyl, pharmaceuticals, fertilizers, and explosives. Most interesting was the **compounding of synthetic rubber** right before the eyes of the group, a demonstration of the properties of Freon-12 refrigerant, as well as of many **petrochemical plastics.**

Southern New England

Field Editor
A. D. Nichols
May 21

THE ANNUAL SPRING SOCIAL of this Section was held at the Wethersfield Country Club. After cocktails and **dinner,** a gift was presented to retiring chairman, L. Morgan Porter. Movies, and **dancing** were also part of the evening's entertainment.

Twin City

Field Editor
S. H. Knight
May 12

"THE NEW PACKARD LIGHTWEIGHT DIESEL ENGINES" was presented by one of its three authors, Ross E. Taylor. Taylor is assistant chief engineer of Packard Motor Car Co., Detroit. (The

Twin City May 12

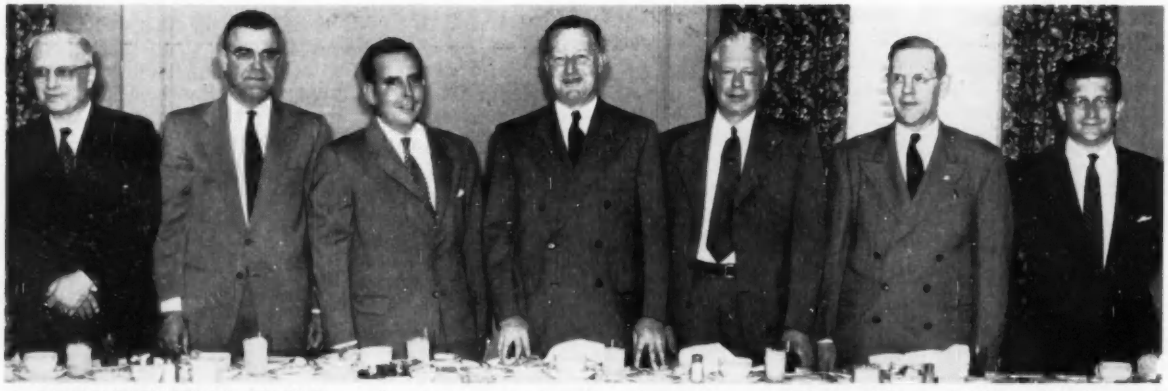
From Section Cameras

EXAMINING SLIDES are: (left to right) Section Treasurer Arthur C. Cragg; Speaker Ross E. Taylor, assistant chief engineer of Packard Motor Car Co., Detroit; Section Secretary Leslie Foster. Taylor showed the slides during his presentation of "The New Package Lightweight Diesel Engines."

Rochester Division of Buffalo Feb. 17

EDUCATION AND INDUSTRY got together at Rochester Division's forum. Left to right: Regional Vice-Chairman H. Clark; W. Magratten, senior, University of Rochester; University of Rochester's Dr. L. D. Conta; G. C. Whitaker, president, Graflex, Inc.; Moderator H. C. Jones; H. W. Brandt, general manager, GMC's Rochester Products Division; Cornell University's Prof. H. J. Loberg; P. D. Hansen, student, University of Rochester.

Syracuse May 21



A PRESIDENTIAL VISIT to the Section took place last May. SAE President William Littlewood (fourth from left) is shown at the dinner table before he addressed members and guests. Others at the table are: (left to right) Section Meetings Chairman Alfons Alven; Paul Schweizer of Schweizer Aircraft; William Kelsey, Elmira vice-chairman; Littlewood; Claude Bigelow, Syracuse chairman; Glen Dingman, Sidney vice-chairman, and Prof. E. B. Watson of Cornell University.

other two authors are Marsden Ware and Julius Witzky, both of Packard. (The complete paper will appear in the 1954 SAE Transactions.)

Some interesting specifications are the acceleration rate (from zero **to 1500 rpm in one second)** and the horsepower to weight ratio (1/5). The engines were designed especially **for PT boat use** where long life and light weight are essential.

Compression ratio of the engines is 15/1 and specific fuel consumption .43 lb bhp hr.

In point of horsepower to weight ratio, the Packard diesel falls **above aircraft types,** but well below automotive type diesel engines.

Taylor, when asked about cold weather starting characteristics of the engine, stated that sub-zero temperatures are not involved and that for normal **cold weather starting,** ether starting in capsule form was found satisfactory.

Design features include a turbosupercharger to provide exhaust heat recovery, hard surface cylinders, and four valves per cylinder.

This talk is the same as was given before the National Diesel Engine meeting in Chicago in November, 1953.

Mohawk-Hudson

Field Editor
L. F. Smith
May 14

DANCING AND DOOR PRIZES were among the festivities at the Group's third annual "Ladies Night." **Prizes** were all donated by local companies and were the source of a great deal of fun. A **buffet supper** was served and wound up activities for the '53–'54 year.

The only **serious business** took place when next year's officers were announced and Ralph Hooker, '53–'54 chairman, received his past-chairman's certificate.

Atlanta

Field Editor
F. D. Thompson
May 17

PAST-PRESIDENT RALPH TEETOR was on hand for the final meeting of the year of the Atlanta Group. Teetor is president of Perfect Circle Corp., Hagerstown, Ind.

He told the Group how much he had enjoyed being a member of SAE for **over 40 years,** what it meant to him, what the Society has meant to industry and to its members. In 1925 he served as chairman of the Indiana Section, in 1930 he began a two-year term on the Council of the national organization. In '33 he was appointed chairman of the Research Committee, which he held until 1936 when he was elected president. He has also been a member of SAE's Technical and War Engineering Boards.

Teetor presented the **piston ring story** for the very first autos up to present day rings. He had samples with him to help explain the problems encountered.

He had also brought along a demonstration model of his latest invention, **the Speedostat.** He explained its design and operation to the Group.

Southern California

Field Editor
W. E. Achor
May 3–5

A THREE-MEETING SEMINAR to cover significant problems in the engineering of passenger and racing cars was held by this Section last May.

Of interest was Griffith Borgeson's presentation of the activities of **prominent designers** of American race cars and characteristic features of their designs. Borgeson is codirector of Jaderquist-Borgeson, Inc., Los Angeles. "Development of the American Racing Engine" was another presentation of Borgeson. He traced the history of the Miller and Dusenberg engines and showed how this line of engines finally produced **today's Offenhauser** engines.

According to Ray McMahan of the Socony Vacuum Corp., it appears that existing passenger-car **engine oils** meet all requirements of racing engines. McMahan's paper, "Fuel and Lubricant Requirements of Racing Engines" was presented by Chet Barrand of the General Petroleum Corp.

Z. Arkus-Duntov was on hand to discuss how car performance is defined for the **passenger, sports, and racing car.** Duntov is with GMC's Chevrolet Division.

Other speakers were: Gilbert Way, Ethyl Corp.; John W. Oehrli, Paxton Engineering Corp.; Peter Kyropoulos, California Institute of Technology; and H. M. Stilley of Firestone Tire & Rubber Corp.

Central Illinois

Field Editor
W. J. Lux
May 17

A CONTROVERSIAL SUBJECT is the exact realm and future position of the gas turbine, according to Henry C. Hill of Boeing Airplane Co.

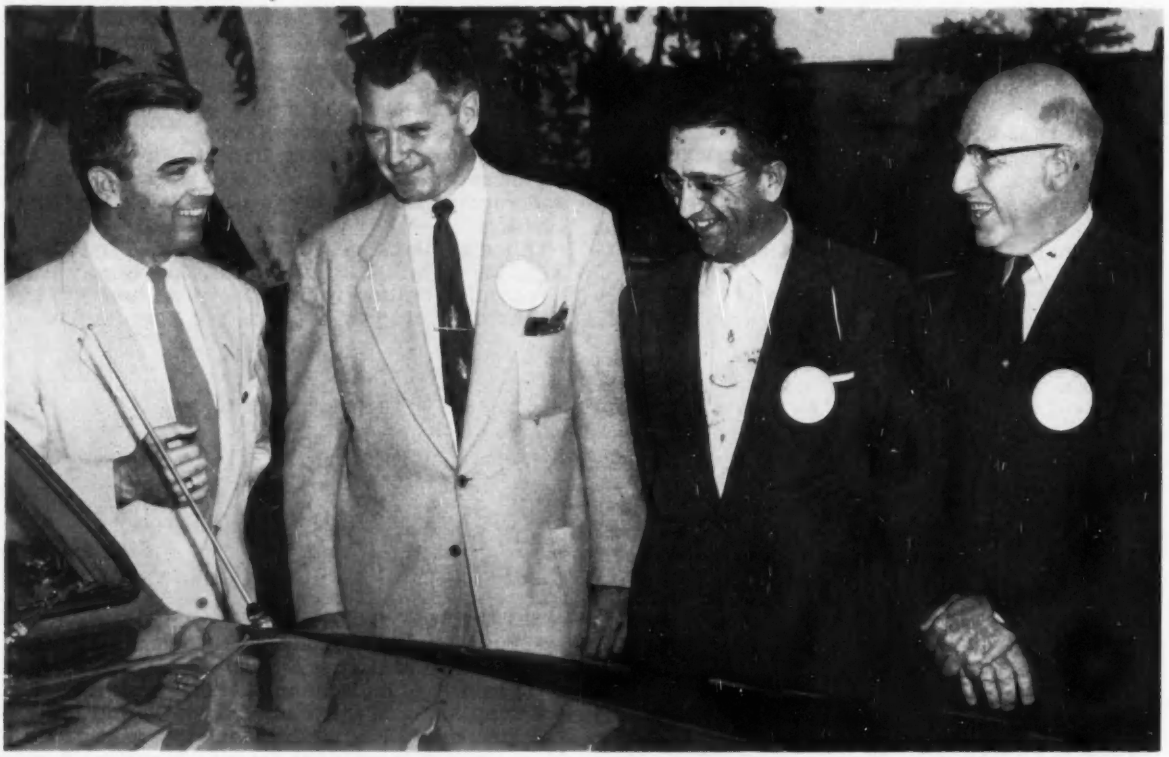
He said that high manufacturing cost, high fuel consumption, and uncertain reliability and life expectancy might lead to the conclusion that gas turbines are **for the distant future.** However, Boeing has tested their basic gas turbine engine, Model 502-2, in a variety of installations and conditions. **Much development** has been done and improve-

Mohawk-Hudson Group May 14

From Section Cameras

SHAKING HANDS are Edward Light (right), vice-chairman for 1953-54 and newly elected chairman for '54-'55, and Ralph Hooker, '53-'54 chairman. Hooker is shown being presented with his past-chairman's certificate at the Group's "Ladies Night" meeting.

Texas Gulf Coast May 14



EXPLAINING THE FINER POINTS of American and European sports cars is Mel Martin (extreme left), feature columnist for the Houston "Post." Section members are: (left to right) Meetings Chairman E .J. Bowhay, Secretary R. C. Marr; and Section Chairman E. J. Strawn.

ments, particularly in construction and methods of manufacturing components, have aroused active interest.

Even though this engine is **one of the most challenging** developments now under consideration, Hill believes it will play a large and important role in the future.

Among its advantages that make it attractive to any user of small powerplants, Hill listed:

1. Less Noise
2. Smooth operation
3. **Ideal torque** characteristics
4. Almost complete elimination of cooling requirements
5. Flexibility of control
6. More lenient fuel and lubrication requirements
7. Small size and weight

Rochester Division of Buffalo

Feb. 17

A YOUNG ENGINEER with the ability to get things done has an increasingly **challenging future,** according to H. W. Brandt. Brandt is general manager of GMC's Rochester Products Division.

Speaking for industry at the "Education and Industry" forum of SAE's Rochester Division, Brandt said that **opportunities** for the young engineer were never greater. He said that the **trend toward automation** is going to create more and more jobs for engineers, who will design and develop the machines and processes.

L. D. Conta, president of the Association of Engineering Colleges, New York State, and chairman of the Division of Engineering, University of Rochester, spoke on the **objectives of engineering education** today. He said educators are to give students the fundamental principles, facts, and methods of using these principles and facts to enable them to learn what they need to know to become competent professional engineers and useful citizens, but mostly to provide them with a basis for more learning.

He said that one of the important changes has been the addition of courses in the **humanities and social studies.** Conta believes these are the fundamental courses underlying applied courses in business management. Another important change is that **specialization has almost disappeared** today. ". . . It has become relatively impossible to train a specialist in four years. Each of these specialties has grown to such proportions in recent years that no matter how much time one puts to the subject, one cannot become an expert. The progress in a given year is often more than a man **can learn in a year,** so that in a real sense the longer one stays in college studying these things, the farther behind he gets."

Other participants in the forum were: G. C. Whitaker, president and general manager, Graflex, Inc.; Prof. H. J. Loberg of Cornell University; P. D. Hansen, student, University of Rochester; W. J. Magratten, senior, University of Rochester; H. C. Jones, moderator.

Dayton

Field Editor
P. J. Long

May 27

REDUCTION IN DUST, POLLEN, TRAFFIC FUMES, wind, and noise by use of auto air conditioning was discussed by D. C. Perkins, body engineer of GMC's Oldsmobile Division.

Perkins told members that the Oldsmobile car conditioning system gives **a constant supply** of outside air. He said that this insures a continuous change of conditioned air within the passenger compartment, and **helps remove smoke** and "stuffiness." Since the outside air is cooled by the evaporator before entering the car body, there is no tendency to increase humidity. Addition of outside air also increases pressure within the body, **reduces warm air** and dust entry.

A self-charging electrostatic pliotron filter for dust and **odor removal** is also included in the system. By means of adjustable nozzles, cool air can be directed in the faces of passengers. This provides **immediate comfort** and may be used after the car has been parked in the sun for a long time, when interior temperature is sometimes as high as **160 F.**

Buffalo

Field Editor
D. I. Hall

May 18

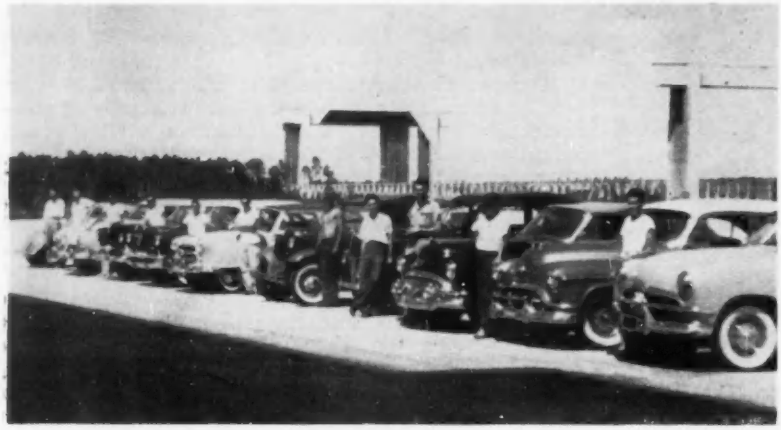
POST-WAR EUROPEAN CARS generally cost less, use less precious motor fuel, and are smaller, lighter, and narrower than American cars. This is what Maurice Olley told members at the Second Annual Golf Meeting of Buffalo Section. Olley presented his paper, "Passenger Cars—**European vs. American.**" Olley is director of research and development of GMC's Chevrolet Motor Division.

Europeans must consider their transportation systems, fuel cost, and standard of living, in designing cars. Consequently, they strive for **maximum interior dimensions** while maintaining minimum exterior dimensions, weight and cost. In attempting to achieve this goal, certain features must be sacrificed, among them ride and **noise level.** Both of these are generally inferior to American standards. On the other hand, European autos generally excel in road-holding ability and nimbleness.

Olley also said that both the European and American cars are designed to fit the **special cases determined** by each ones conditions, and are not built to be interchangeable.

A **sports car exhibition** was held prior to the meeting, and approximately forty cars were exhibited. A ten minute film covering the Corvette, Chevrolet's venture into the sports car field, was then shown to members.

University of Miami (May 8)



"SAE Economy Run" contestants of the SAE Club at the University are shown on the South Campus. This has been one of the most successful and outstanding events of the Engineering School's Activities.

University of Miami

The "SAE Economy Run," sponsored by the SAE Club at Miami was one of the most successful and outstanding events of the Engineering School's activities. Another contest is anticipated for next year.

The run took place last May 8 on a planned course at Miami's South Campus. John Gudrige won with 24.25 miles on one gallon of gasoline. This was not the greatest distance travelled, but since the competition was based on the ton-mile, Gudrige still won with a total of 56.23 ton-miles.

"The Miami Engineer," student publication, had fun reporting the contest. Headline read, "Gudrige Wins Run, Faculty Lose."

". . . This was one day that Dave Guthrie will never forget. After dragging, pushing, and pulling his 1940 Ford "60" a distance of 37.18 miles, he thought for sure that it was in the bag for him. But, after final official computation of the results, he found that he had only 54.45 ton-miles against Gudrige's walloping 56.

". . . Prof. John Gill pushed his 735,000 gram Volkswagon into 10th place with 41.55 miles but only 33.68 ton-miles. Two feet in back of Gill was Prof. W. B. King in his conservative '51 Crosley going 36.81 miles which makes 26.32 ton-miles. Professor King claims that the flat tire he received in the middle of the contest threw him off balance. The wind was also two degrees off from what he had anticipated."

The Club's recent paper contest is another event which has achieved prominence for the group. Results were: First prize, William Polon, for his subject "Jet Transports." Polon was invited to deliver his paper before the annual convention of the Florida Engineering Society May 7. Second prize, Caleb P. Rohm, for his paper "Design of a Lime Recalcination Plant." Rohm was invited to deliver his paper before the meeting of the Miami Section of the American Society of Mechanical Engineers, May 26.

Parks College (May 11)

A set of "Billiken bookends" is presented to Albert Hazell (second from left) for sponsoring the students by contributing half of the cost of each student's dinner for the entire year. Hazell is president of Hazell Machine Co., Inc., St. Louis. At left is Frank Meyers, Student Branch advisor, and at right is Monroe Alves, chairman of the St. Louis Section. Student Chairman Harry Oravetz makes the presentation.

Parks College

The SAE Branch at Parks has been very active. This spring the students took over one of St. Louis Section's regular monthly meetings, with student officers taking the positions of Section officers.

Student Chairman Harry Oravetz conducted the meeting and introduced other student officers. He also pre-

Student News

Academy of Aeronautics (April 13)

In front of jet are Branch members who toured Republic Aviation Co.'s plant at Farmingdale, N. Y. The plane is a swept-wing version of the F-84. Students met at the Casey Jones School where new Republic employees are trained and then went to the plant via a bus furnished by the company. After the tour, they ate at the plant cafeteria as guests of Republic.

University of Michigan (March 10)

A trip to General Motors Transmission Division's new plant at Willow Run was made by Branch members last March. The plant is about 15 miles from Ann Arbor, Mich.

SAE Student News

continued

sented the evening's speaker, Jerome Lederer. Lederer is director of the Cornell-Guggenheim Aviation Safety Center.

At the May meeting of St. Louis Section, the students presented a set of bookends to Albert Hazell, president of Hazell Machine Co., St. Louis. Hazell has been picking up half of the students' dinner checks at each meeting for the last two years. He has helped not only Branch members at Parks, but at the Missouri School of Mines at Rolla, Mo.

LOW COST DESIGN

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ROCKFORD CLUTCHES

Academy of Aeronautics

On April 13, the Academy of Aeronautics' Student Branch went on a guided tour of Republic Aviation Co.'s plant at Farmingdale, N. Y.

The group first met at the Casey Jones School in Farmingdale where the new Republic employees are trained. There members received passes and were taken to the plant via a bus furnished by Republic. First stop at the plant was at the flight testing and run-up section. The students were fortunate in arriving just as two F-84's were taking off.

Next they went through the hangar where aircraft is given an inspection after the flight test. Observed were RF-84's and F-84's in various stages of disassembly. This afforded an excellent opportunity to get a look at the engine installation and other aircraft components.

They then moved on to the production line and observed planes being manufactured from virtually raw materials. Of interest were the elaborate jigs and fixtures needed to insure proper alignment and the enormous amount of machinery necessary for production and inspection.

The students then ate at the plant cafeteria as guests of Republic.

Chrysler Institute

The Student Branch at Chrysler Institute concluded its formal activities for the year on May 13 by having Supt. Frank Jessup and Sgt. Elmer C. Paul, both of the Indiana State Police Department, and George McCain, staff engineer with Chrysler, participate in a panel discussion on auto crash injuries.

Sgt. Paul, who instigated the "Auto Crash Injury Research" program in Indiana, showed the report form used by police when reporting rural fatal accidents. Only 10% of fatal accidents were caused by a mechanical failure, which includes failures of proper maintenance. Therefore, the remaining 90% of accidents were some fault of the driver.

It is not very likely that the importance of safe and courteous driving habits can be impressed on all drivers, he said. Therefore, it may be readily seen that much responsibility lies with the automotive designers in making cars to reduce the severity of injuries in accidents.

It was pointed out that in 43.5% of fatal accidents, doors on the car opened and spilled out 47% of the fatalities. This would indicate that one of the

most important possibilities for improvement lies in designing door locks. The use of safety belts was also discussed as an aid in keeping occupants in the car.

Other results of the research conducted showed it was better to have the steering wheel spokes break off at the hub instead of at the rim to avoid piercing the chest.

McCain, who is a member of the AMA Committee on Safety, cited three phases of safety in car design which should be considered by present and future automotive engineers. These are:

1. To design the car to fit its occupants and therefore reduce accidents resulting from driver fatigue
2. To make the car as mechanically sound as possible, and
3. To design the car so that in case of an accident the possibility of injury from the interior parts of the car will be reduced.

Students Enter Industry

JAMES E. McLAIN (Purdue '54) is a welding specialist for General Electric at Fort Wayne.

A. F. M. ABDUL AZIZ (Michigan State '54) is now a trainee at GMC's Fisher Body Division, Lansing, Mich.

L. N. FLEM (Tri-State '54) has joined the Westinghouse Air Brake Co., Wilmerding, Pa. as a junior engineer.

ROBERT L. FRANZEN (Colorado University '50) is with Horning-Cooper, Inc. of Monrovia, Calif., as an engineer.

ANDREW J. KOZLOWSKI (Northrop Aeronautical Institute '53) is with the Diesel Equipment Division of General Motors, Grand Rapids.

JOHN W. HANCOCK (Tri-State '53) is an engineer trainee for the National Tube Division of the U. S. Steel Corp., Gary, Ind.

RALPH F. TODD (Michigan State '54) is at General Motors' technical center in Detroit. He is an engineer in training.

PETER C. HORNER (Highland Park '51) has become a test engineer for Chrysler Corp.'s Ordnance Development Division, Detroit. Horner is in the government vehicles section.

B. J. BARTLETT (Tri-State '54) has joined McDonnell Aircraft Corp., St. Louis, in the engineering-thermodynamics department.

WILLIAM R. PHILLIPS (Missouri School of Mines & Metallurgy '54) is now serving in the U. S. Air Force.

DONALD C. THOMPSON (University of Pittsburgh '54) is now a junior engineer at the Bendix Products Division of Bendix Aviation Corp., South Bend, Ind.

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Mono-Built Design Proves Sound from Start

Based on paper by

MILTON S. BALD

Hudson Motor Car Co., Division, American Motors Corp.

EXPERIENCE with the unitized body type shows the structure to be sound and adaptable to economical manufacture of any existing body type. It is flexible in styling, extremely roadable in operation, economical in maintenance and of extreme long life.

Counter to widespread belief, this type of construction is suited to convertibles. We find it imparts greater rigidity than separate frame and body construction, even with the usual subframe assembly which reduced road clearance considerably.

Some have contended that light gage metal in underbody members would cause sagging or failure after normal corrosion in a couple of years. This is unfounded. We have seen cars six years old, with over 100,000 miles service, and utter disregard of corrosion protection—no undercoat, no garage, no wash—which still show no sign of structure weakening to permit perceptible sagging.

In cases of collision, the cost of repair is reduced. There is less collapse and no need to align separate body and chassis frame units so that their mounting points will meet. (Paper "Hudson Mono-Built Construction" was presented at SAE Mid-Michigan Section, Owosso, Jan. 25, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Enamels and Lacquers Still Battling It Out

Based on paper by

RALPH J. WIRSHING

General Motors Corp.

ONE of the chief advantages of lacquer is its exceedingly rapid drying and its lack of any accompanying chemical change. This makes it possible to make repairs rapidly and with minimum trouble.

Most field repairs are made with lacquer regardless of whether the original paint job was lacquer or enamel. Repairing enamel with enamel is difficult, primarily because of chemical change which took place during baking. The chemical change causes a slight shift in color so that the repair spot is not a perfect match. Rapidity in drying simplifies the painting of cars in two

colors, since the first color can be masked off almost immediately and the second color applied.

Probably the greatest disadvantage of lacquer lies in the fact that it is polished. Some spots get rubbed thin, but they cannot be detected in the plant. When the customer does more polishing, the thin spots rub through.

According to field surveys, enamels in use today are more subject to blistering and checking than lacquers. When it comes to the all important feature of luster retention, the two materials behave much the same when matching colors are compared. The enamel suffers somewhat in this respect, once the film has been polished, after weathering.

Most complaints regarding paint which are made by car owners, are not related to a failure of the finish itself. They are, for the most part, concerned with corrosion which results only where the paint film is broken.

Most automotive finishes withstand the abuse to which they are subjected in a highly satisfactory manner. There has been a gradual and steady improvement over the years and there will be more in the future. (Paper "Lacquer as a Finish on Automobiles" was presented at SAE National Passenger Car, Body and Materials Meeting, Detroit, March 2, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

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Based on paper by

F. D. HABERKORN
Caterpillar Tractor Co.

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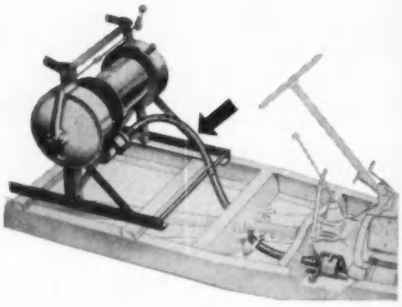

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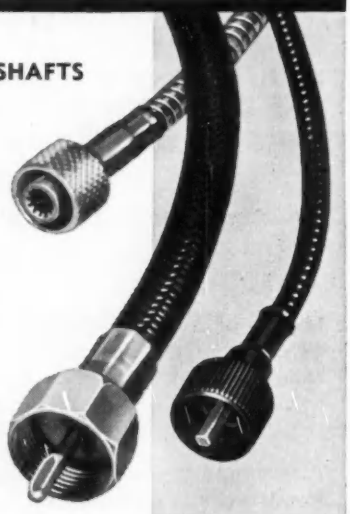

P-2

BULLETIN 5306 gives details on how to select and apply flexible shafts. Send for your copy. Address Dept. J.

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toward coming up with what appears to be needed, and then, confident in the soundness of your basic planning, relax while a commercial market is built up. Being smart, you will only relax long enough to catch your breath and then turn on your other eye, the "fishy" one, for a sort of "reviewing" type look at the new brain child as it first hits the market. You will know that some of the first are going into the hands of those three famous engineers who can out-test any private proving ground or laboratory in the world—Tom, Dick and Harry. And, from them you can learn about the little things that, when fixed, can do so much to hasten the day of universal acceptance.

Fail to heed their suggestions, at least to the point of giving them full consideration, and you may well be passing up some of the most valuable counsel available.

(Paper "Engineering—Sales—Progress" was presented at SAE Earthmoving Industry Conference, Peoria, April 13–14, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Body Spray Painting Going Fully Automatic

Based on paper by

R. E. VanDEVENTER

Packard Motor Car Co.

MANY of the more than 25 variables claimed to be involved in spray painting are subject to the action of the man who handles the gun. It is not surprising, therefore, that the major activity in spray technique is aimed at replacing the man with mechanical devices which are more reproducible.

Automatic spraying has been used for several years for primer surfacer on roofs of bodies, and more recently for color as well. It has also been used in at least one plant for both primer and color on sheet metal. Electrostatic spray has become fairly common for moldings and small parts, and in one body plant it is used for application of primer surfacer.

Quite recently, a major advance towards automation in painting has occurred with several plants using full mechanical spray for all exterior coats of both primer-surfacer and color. Hand operations are performed around door and window openings. A decided improvement in quality in terms of uniform film thickness, appearance, and number of rejects is reported. While cost data is not available, it is assumed the installations are justifiable economically. Several other plants are known to be experimenting or con-

sidering installation of automatic spray facilities for some operations. (Paper "Automotive Paint Processes and Equipment" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 2, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Based on Discussion

Question: What do you consider the best humidity conditions for spraying lacquers and enamels?

Answers:

Mr. VanDeventer: High humidity constitutes a problem in the shop. It is impossible to give definite humidity values that work consistently well in every place. High humidity must be avoided and previous production experience serves as a guide.

A. J. LaPointe, Ford Motor Co.: Low humidity causes flow difficulties, whereas high humidity is responsible for pinholes and other trouble. It is difficult to recommend an iron-clad rule for humidity percentage.

Julius Gauss, Retired—formerly with Studebaker: In my experience, a relative humidity reading of approximately 65% is a recommendable percentage; it helps decidedly in the "leveling" of the film. However, humidity in the booths should be kept lower to avoid pinholes. The effect of the humidity on the operator should also be considered.

More Powerful Units Coming in Earthmoving

Based on paper by

K. M. LEECH

Cummins Engine Co.

THERE have been relatively few twin-six or single V-12 engines used in shallow pit mining equipment. Here may be a case where a more powerful engine can result in decreased load factor with the consequent increase in operating and maintenance life. By this is meant using the larger power units in vehicles hauling comparable pay loads to those now being handled in existing equipment.

In deep pit mining equipment the trend has been for the top of the vehicle weight—power curve to increase up to the 300 hp size and then to decrease as more powerful engines and vehicles become available. This indicates that load factors had increased and performance decreased to a point where, with the engines available at the time, operating economies de-

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manded increased power per pound of vehicle.

It is our opinion that this trend will become more pronounced in the future. At least, there will be vehicles offered in the large sizes that have the lower gross vehicle weight per horsepower that are now available in smaller units. (Paper "Engine Requirements for Earthmoving Equipment" was presented at SAE Earthmoving Industry Conference, Peoria, April 13–14, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Straight Wings Excel Deltas at High Speed

Based on paper by

C. L. JOHNSON
Lockheed Aircraft Corp.

WITH the solution of the aeroelastic problems associated with the unswept, very thin wing, this planform appears to have substantial advantages over other types when evaluated on a strictly comparative basis for a flight regime which reaches well into supersonic speeds.

This is the conclusion of a paper discussing problems encountered at low speed and in supersonic flight with aircraft having different wing planforms. The delta-wing type is compared to the unswept or straight thin wing. The solution to the structural problem having been obtained for the latter wing, the unswept type is superior to the delta type when strictly comparative missions and operating field lengths are considered. (Paper "Airplane Configurations for High Speed Flight" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

No MPG Miracles Trace to Oil Additives

Based on paper by

CARL W. GEORGI
Quaker State Oil Refining Corp.

Complete paper will appear in 1954 SAE Transactions

TO measure fuel consumption under various speeds and loads and with a variety of motor oils, dynamometer tests were run with a popular make of

passenger car engine. Tests on each oil were run at engine speeds equivalent to 15, 30, 45 and 60 mph on the road, and at loads of 25, 50, 75 and 100%. Each oil was tested under 16 different load-speed combinations. Check fuel consumption readings were taken at each setting, so that a minimum of 32 consumption readings was made in each test run. From these tests the following conclusions may be drawn:

1—Popular types of "oiliness" or "friction reducing" additives display no measurable improvement in engine friction, power, and fuel economy over that of the motor oil to which they are added.

2—Viscosity is the only significant property of motor oils relating to engine power, friction, and fuel economy.

3—"Engine viscosities" of some motor oils may be quite different from their "laboratory viscosities" as measured in conventional Saybolt or Kinematic viscosimeters, due to the effects of pressure, and of shear rate on oils of non-Newtonian character.

4—Low V.I. oils are indicated to have "engine viscosities" appreciably higher than their "laboratory viscosities", possibly due to the fact that low V.I. oils are much more sensitive to viscosity increase with increase of pressure.

5—Oils containing V.I. improving polymers are indicated to have "engine viscosities" appreciably lower than their "laboratory viscosities," probably due to the fact that such oils are non-Newtonian and develop considerable loss of viscosity at high shear rates. Engine tests on oil consumption indicate the same conclusion. (Paper "Some Effects of Motor Oils and Additives on Engine Fuel Consumption" was presented at SAE Annual Meeting, Detroit, Jan. 14, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Based on Discussion

H. F. Galindo and **J. A. Miller**, California Research Corp.

There are several important factors missing in the otherwise excellent and precise laboratory engine results presented by the author. His engine and dynamometer stand were not equipped with a traffic light or a parking lot. Even in the Far West, the number of "wide-open spaces" to drive a car at high speeds and loads are diminishing rapidly, and traffic driving has become a major factor affecting gasoline and lubricating oil mileage.

We agree that "engine viscosities" are the primary factor influencing instantaneous engine power, friction, and fuel economy. However, the magnitude of the fuel savings effected with

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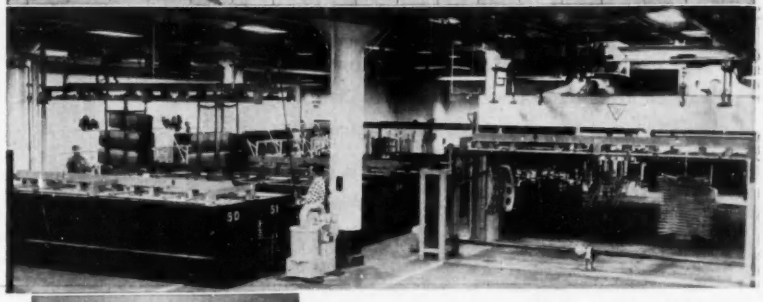

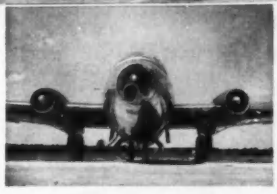

View of a modern "Alodine" No. 1200 installation at the Glenn L. Martin Company plant, Baltimore, Md. In these dip tanks, aluminum components of the USAF B-57 (top) are protectively treated with American Chemical Paint Company's "Alodine" No. 1200.

Alodizing creates a durable bond for paint, and greatly enhances aluminum's natural corrosion resistance, particularly in salt air. Alodizing meets the requirements of Military Specification MIL-C-5541, and was adopted by Martin after a long test period.

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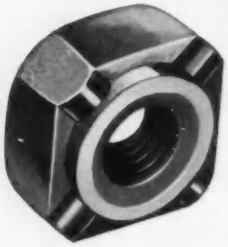

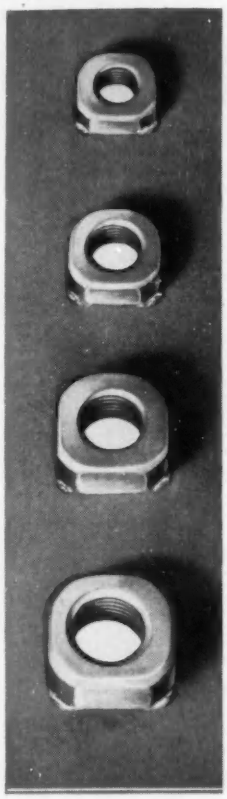

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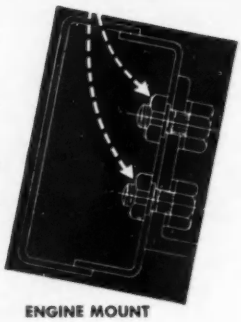

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certain types of V.I. improved oils has not been evaluated by Mr. Georgi in terms of the type of driving that many motorists are accustomed to.

L. J. Grunder, Richfied Oil Co.

The extensiveness of the author's data on one engine type should encourage others in the future to further this information by running engines of even lower internal friction—where the viscosity factor may be of even greater importance percentagewise.

Based on Author's Closure

Laboratory tests were conducted on three different engine makes, two of the newer low-friction types having bore diameters greater than their piston strokes, and the third an engine of older basic design with stroke greater than bore diameter. Test data from all three were so similar that the data presented can be considered typical.

A series of road tests was also run which warrant conclusion that operating conditions can make a difference of over 100% in "miles per gallon" fuel consumption, whereas differences in oils as to viscosity and additive treatment rarely show more than a few per cent difference in "miles per gallon" when compared under similar driving conditions.

Wedding Two Engine Types Yields Prize Baby

Based on paper by

A. L. LONDON

Stanford University

Complete paper will appear in 1954 SAE Transactions

THE gas turbine powerplant is making a successful bid to displace the conventional reciprocating engine in aircraft applications. This is so despite a specific fuel consumption approximately twice that of the reciprocating-engine-propeller system. The fuel economy disadvantage is more than offset, at least for most military applications, by gains in power compactness, aerodynamic shape, specific weight, and basic mechanical simplicity.

If a marriage of the reciprocating and turbine type engines were effected, the resultant free-piston and turbine compound-engine would have the following major advantages relative to the conventional crank-type engine:

1—Substantially greater mechanical simplicity, providing for both lower manufacturing cost and ease of maintenance.

2—Flexibility in operation and ex-

cellent torque-speed characteristics because of the "fluid-coupled" turbine drive.

3—Vibration-free operation afforded by the opposed-piston arrangement resulting in a substantial economy in foundation requirements.

4—A relatively low specific weight.

These advantages are gained without sacrifice of fuel economy, as in this respect the free-piston compound engine compares favorably with the conventional diesel, the modern record-holder for prime mover thermal efficiency. (Paper "The Free-Piston and Turbine Compound Engine—Status of the Development" was presented at SAE Annual Meeting, Detroit, Jan. 15, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.

Pre-Flight Exhaust System Test a Success

Based on paper by

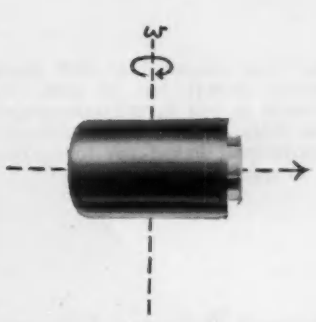
C.F. DERBYSHIRE
Rohr Aircraft Corp.

TO test large aircraft engine exhaust systems before flight, equipment was designed for sea level testing which provided all of the important factors affecting performance at altitude.

Various type exhaust systems, including many innovations, some novel, were tested. Some of the ideas proposed were quickly shown to be incapable of withstanding the combination of pressure, temperature, and vibration for which they were designed. From an overall standpoint it is generally conceded that much time and money was saved in the course of evaluating the performance of the then new design of the exhaust system of the B-36 airplane, and significant steps were taken toward an early correction of the inevitable faults which arise in the early phases of any new engineering program.

The test apparatus was unusually successful in the forecasting and eliminating of faults which would have been extremely unwelcome in flight. The test was apparently severe though accurate as evidenced by the fact that systems which were corrected to survive 500 hr of ground testing have uniformly exhibited the ability to withstand more than 500 hr flight service and, in many cases, up to 1000 hr. The author presents a detailed description of the apparatus used and gives examples of the faulty design and construction revealed by the test. (Paper "Simulated Altitude Tests of Large Aircraft Engine Exhaust Sys-

Kearfott developed RATE GYROS in production



Eight basic rate gyros developed and produced by Kearfott are available for rate measurement, rate integrating or rate cutout applications.

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Type	Max. Output Null Ratio	Ratio Max. to Min. Input Rate	Dimensions	Weight
STANDARD	300:1	1000:1	2 3/8" x 3 7/8"	2 lbs.
HIGH SENSITIVITY	1000:1	2000:1	2 5/16" x 4 1/4"	4 1/2 lbs.
MINIATURE	1000:1	1500:1	2" x 3 5/16"	1 lb.

FLOATED RATE INTEGRATING GYROS

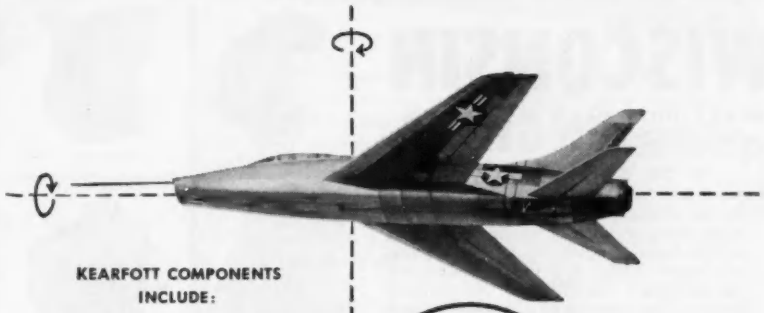
Type	Damping Ratio	Dimension	Weight	Drift Standard Deviation
HIGH ACCURACY	.3	6" x 3 3/4"	6.4 lbs.	.1°/hr.
MINIATURE	1	2" x 3 21/32"	1 3/8 lbs.	1/3 millirad/sec.

GYRO ACTIVATED RATE SWITCHES

Type	Cutout Rate	Dimensions	Weight
STANDARD	25°/sec.	3 1/2" x 5 3/32"	3 3/4 lbs.
MINIATURE	25°/sec.	3 1/2" x 4 3/16"	2 3/4 lbs.
SUBMINIATURE	15°/sec.	2" x 3 5/16"	3/4 lbs.

Kearfott Gyros are hermetically sealed in a dry inert gas and feature high pickoff output thus eliminating bulky external amplifiers.

Additional data and prices will be sent on request



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West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

A GENERAL PRECISION EQUIPMENT CORPORATION SUBSIDIARY

tems" was presented at SAE Annual Meeting, Detroit, Jan. 13, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Camera Reveals Causes Of Passengers' Fatigue

Based on paper by

WALTER E. LAY

University of Michigan

Complete paper will appear in 1954 SAE Transactions

PROBABLY the most disagreeable passenger motion is caused by a cyclic movement of the car when it passes over a series of bumps, each successive bump adding to the violence of the action.

By means of a movie camera mounted well outside the right side of the car, it is possible to show the movement of the passenger and to chart it. Fig. 1 illustrates the movement of the head, trunk and thighs. It will be noted that in one position the spine is nearly straight and in another it is flexed into a curve. As the shoulder point begins to move backward the upper end of the spine is still moving forward. The heavy weight of the head is rather poorly supported on the comparatively slender neck and acts much like the snapper on the end of a whip. This action may explain the ache in the neck which often results from a long rough drive.

The whip lash action of the head and neck causes the head to rotate on the hinge point on the top of the spine. Since the eyes must always be aimed at the horizon, they must be continually rocked upward and downward. This action probably causes fatigue of the eye muscles.

On some of the tests, the driver guided the car up to the bumps, then removed his hands from the steering wheel while the car was traversing the bumps. His body was then free to move like that of a passenger in the front seat, and as a result the movement of the head and upper part of his body was nearly doubled. This explains why the front seat passenger is more irritated by a rough ride than the driver. It suggests serious consideration for some kind of hand rest for the passenger. (Paper "What Happens to a Passenger When Traveling in a Car" was presented at SAE Annual Meeting, Detroit, Jan. 11, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

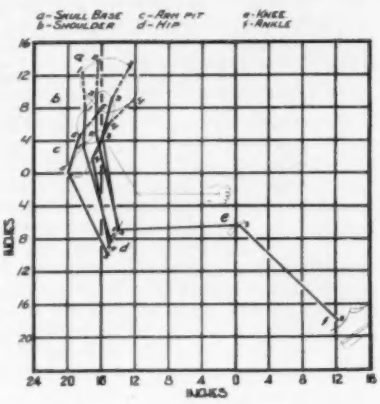

Fig. 1—Here is plotted the movement of the head, trunk and thighs of a passenger when the car he is driving passes over a series of bumps in the road

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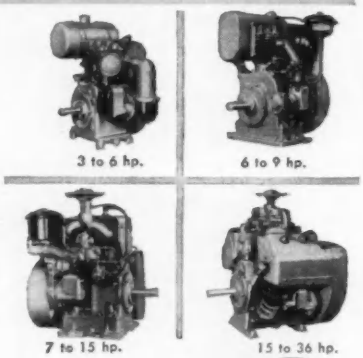

In the design, manufacture, and ultimate use-purchase of mechanized field and industrial equipment . . . Wisconsin Heavy-Duty Air-Cooled Engines are specified as Original Equipment Power Components to a greater extent than any other make of engine, within a 3 to 36 hp. range.

This dominant preference must necessarily be based on actual *performance records* of users . . . because Wisconsin Engines are not sold on a "price" basis. These engines have the inherent Lugging Power that *stays with the job*, eliminating "stop-and-go" delays, saving manpower and manhours . . . and delivering "Most H. P. Hours" of on-the-job service, with minimum servicing.

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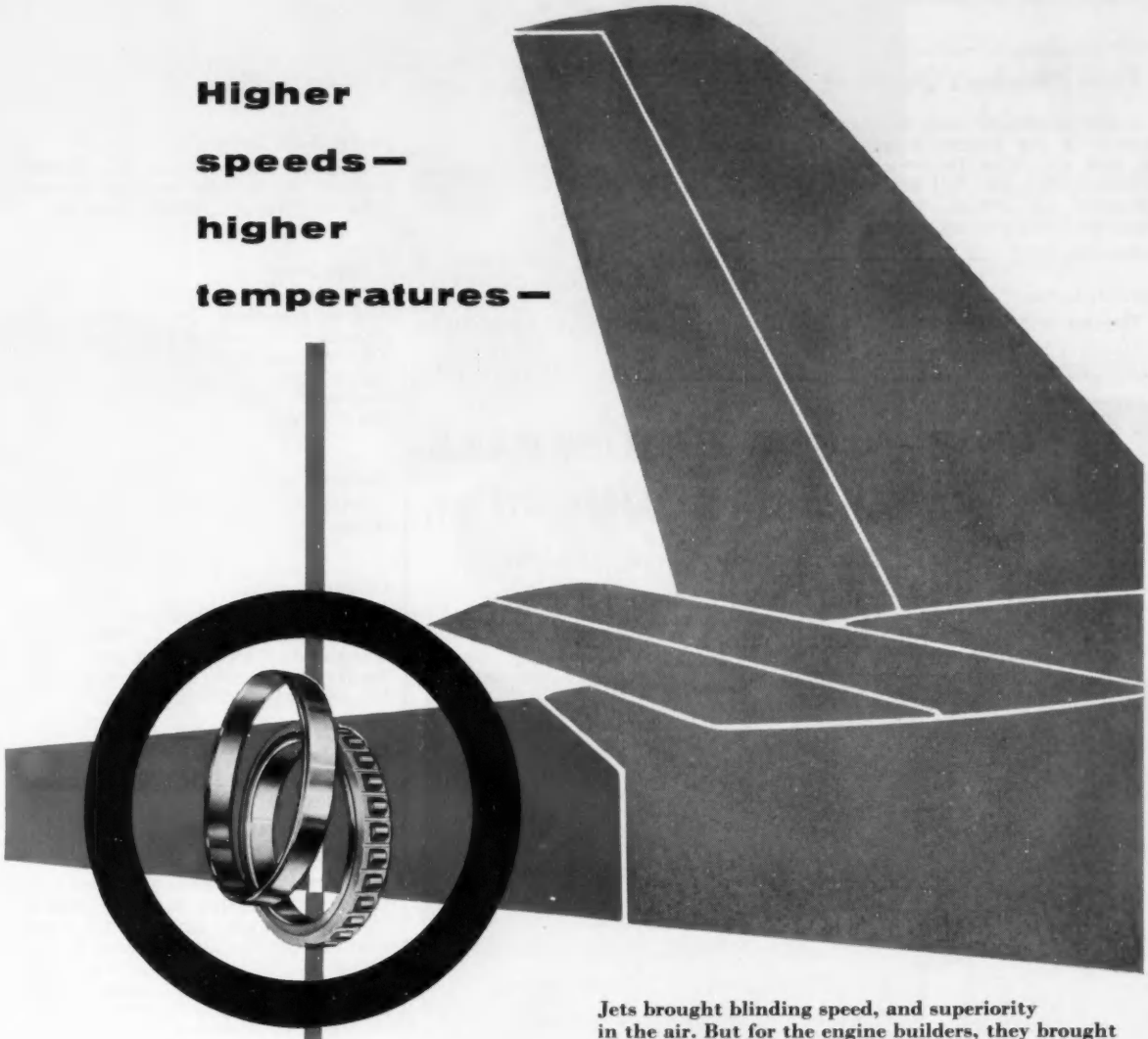
Based on paper by

E. E. HUPP

Bendix Products Division

PASSENGER car weight, brake size, and brake effectiveness have been such that physical effort required to stop has not been excessive and pedal effort, both force and travel, has remained in a comfortable range. However, with introduction of automatic transmissions and consequent elimination of the clutch pedal, the need for reduced brake pedal travel for driving ease became apparent. This need inspired the development of the Treadle-Vac brake, a combined vacuum and hydraulic unit. (Paper "Treadle-Vac—A Modern Power Brake for Passenger Cars" was presented at SAE Mid-Michigan Section, Owosso, May 19, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Higher speeds— higher temperatures—



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Jets brought blinding speed, and superiority in the air. But for the engine builders, they brought problems. With higher speeds came higher operating temperatures, and engine parts, especially bearings, had to be designed to withstand destructive heat. So designers turned to Hyatt. With unexcelled research and development facilities, modern production equipment, and years of experience, Hyatt was a logical choice. Hyatt know-how assured highest quality in mass production, and since 1944 Hyatt has been a major supplier of jet bearings. When design requirements are beyond the capabilities of ordinary bearings, always call on Hyatt.

Partial list of aircraft equipped with turbo-prop and turbo-jet engines using Hyatt Bearings:

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Boeing XB-47C Air Force Medium Bomber
Consolidated—Vultee Model 7002 (XF-92A)
Consolidated—Vultee Turboliner
Douglas XA2D-1 "Skyshark" Navy Attack Bomber
Grumman F9F "Panther" Navy Fighter Plane
Lockheed F-80C "Shooting Star" Fighter Plane
Lockheed F-94A & B Air Force Fighter Plane
Lockheed TO-1 U.S. Navy Version of the F-80G For Use as Jet Trainer
Martin P4M-1 Long Range Navy Patrol Bomber
Martin B-57A U.S. Air Force Version of the English Electric Canberra Medium Bomber
North American AJ-1 "Savage" Navy Carrier Attack and Search Airplane
Northrop F-89A All Weather Fighter Plane
Northrop YRB-49A "Flying Wing" Heavy Bomber
Republic F84F "Thunderjet" Fighter Plane

HYATT

STRAIGHT ROLLER BARREL ROLLER TAPER ROLLER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

New Members Qualified

These applicants qualified for admission to the Society between May 10, 1954 and June 10, 1954. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

Thomas R. Aderton (M).

British Columbia Section

J. D. Finnie (M), William John Mackintosh (A).

Buffalo Section

Robert L. Barager (J), Joseph R. O'Neil (M).

Canadian Section

Samuel F. Bacher (A), Robert M. Campbell (A), Ernest Arthur Clifton (M), J. Gordon Couper (A), Andre R. Ducharme (A), Stanley Edge (M), A. N. Giasson (A), Jack F. Hernick (A), A. Leigh Taylor (A).

Central Illinois Section

Theodore Harry Fones (M), Homer Gurtler (J), William Franklin Lindeman (M), Richard Addison Tolg (J).

Chicago Section

Charles E. Allderdice, Jr. (M), George Boswinkle (M), Raymond F. Gramberg (A), Stanley M. Humphrey (M), William H. Lynch (A), Sidney G. Olling (A), Richard K. Reese (M), Charles H. Skuza (M), Raymond H. Snyder (M).

Cincinnati Section

Bruno W. Bruckmann (M), Carl E. Clutter (M).

Cleveland Section

Don D. Barner (A), E. L. Carlotta (M), Lucien J. Dreyer (M), Willard P. Frissell (J), George Mladsi (M), John Brooks Theurer (J), Donald H. Voelker (J), Norman C. Wintle (A).

Dayton Section

Wilbur J. Oakley (M), 2nd Lt. Eldone H. Truex (J).

Detroit Section

T. J. Ault (A), Sven Backlund (J), Lt. Col. Mieczyslaw Gregory Bekker (M), Robert H. Birney (M), Edo Anthony Conedera (M), James B. DeWolfe (J), John A. Geiger (A), Carl Johan Gustafsson (M), James Leslie Hagener (J), Norman Hagood (J), Gay K. Hall (A), Joseph J. Hill (A), Earl P. Holiday (J), Roy Charles Holmstrom (M), Zbigniew Jania (J), Dave R. Jones, Jr. (A), Charles A. Kelly (M), Cleo H. Key (M), Robert E. Lang (J), Frank B. Lewandowski (M), Ludwik Marceli Liszkiewicz (M), Kent Roger Manning (M), John Modell, Jr. (M), John M. Roop (J), Robert E. Sechrest (M), Gregory Paul Shaltz (J), Jay G. Smith (J), George R. Squibb (M), Noel Edward Stasel (J), Richard Strickland (A), Richard John Tabin (J), John W. Tenhundfeld (J), Joel A. Warren (M), John Edward Webster (J), Frank L. Wetherholt (M), Stephen A. Zdan (M).

Hawaii Section

Harry K. Sproull (A).

Indiana Section

Harold Keith Johnson (M), Paul E. Martin (J), Robert David Morrison (J).

Kansas City Section

Jack C. Marshall (A).

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A Glass of Water Explains How Holley Engineers Took the Stalling Out of Sudden Stops

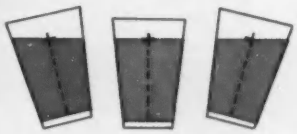
The simple thing you've seen a hundred times—a full glass of water spilling over the sides when carried—explains the reason for a common driving annoyance. Abrupt stops and fast starts frequently cause engines to miss or stall. The reason: the same spilling action in a glass of water occurs in ordinary carburetors with off-set fuel bowls. Abrupt stops and starts pull gasoline away from fuel intakes, starving the engine, or spill quantities of gas into the manifold, flooding the engine.

Holley, working closely with automotive engineers, designed the first concentric type carburetor. Again, the basic theory comes from a glass of water. The depth of the water over the center of the bottom of the glass will remain the same even when the glass is tilted at extreme angles. Thus, by locating all fuel intakes at the center line of the fuel bowl, the engine is always assured of the proper amount of gasoline during fast stops, fast starts, on sharp turns, or when starting on a steep grade. Similarly, the location of the fuel intakes close to the venturi in the Holley off-set bowl carburetor has reduced this driving annoyance on volume cars.

Holley's proven experience in designing increasingly efficient carburetors to meet the requirements of modern engines has produced a record of "firsts" unmatched in the industry. So—if you're wondering how to do a job of fuel metering better and more efficiently, call Holley's Carburetor Engineers. Let them listen, test, recommend and design.

A glass of water explains engine stalling during quick stops and difficult starting when parked on angles. When tipped or carried, water spills over the edge of the glass.

Much the same action takes place in the fuel bowl of a standard carburetor. An abrupt stop or start changes the fuel level forcing gasoline into the manifold, flooding the engine, or—pulls gasoline away from fuel intakes, starving the engine.



The solution to the problem is also graphically explained by the water glass. The depth of the water over the center of the bottom remains the same, no matter which way the glass is tilted.

By locating fuel intakes at the center line of the carburetor fuel bowl, the engine is always assured of the proper amount of gasoline for smooth, efficient performance. This is called true concentric carburetion. Holley Centri•Flo and Centri•Quad carburetors are true concentric design.

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New Members Qualified

continued

Metropolitan Section

Harry V. Chioffe (M), Richard Drukker, Jr. (J), Lt. Col. Elpidio P. Duque (M), Theodore Richard Gondert (J), Donald I. Harrison (J), Thomas W. Johnson (M), John A. Mathe (J), Everett C. Post (M), Frank Wilson Quiggin (M), Robert Simmons Richardson (J), Elmer E. Waters (J).

Mid-Michigan Section

Gerhard W. Sood (J), William Finis Thornburgh (J), Harvey Bertrum Wilgus (A).

Milwaukee Section

Edgar J. Justus (M), William Donald Nelson (J).

Mohawk-Hudson Group

Hansjoerg Stern (J).

Montreal Section

James Gardiner Dick (M), Chipman H. Drury (M), Lt. Col. Anthony Miller (M).

Northern California Section

Robert W. Burchell (M), Bert G. Johnston (M), Frank D. Roberts (J), Vaughn R. Smith (M).

Northwest Section

Aubrey William Albright (A), Jackson A. Blackler (A), R. M. Peterson (A).

Oregon Section

William R. Green (A), Charles A. McGinn (A).

Philadelphia Section

H. Warren Jacobs (M), Leo W. Manley (M), Howard G. Powell (J), William S. Weschler (M), Ray L. Wiles (M), George C. Wright (A).

Pittsburgh Section

Walter Robert Kazor (M).

St. Louis Section

John M. Crocker (J), William A. Scheublein, Jr. (M).

Salt Lake Group

Leon H. Bates (J).

San Diego Section

John G. Brown (M), Robert D. Henschel (A), Hugo F. Mohrlock (J), Ralph E. Molloy (J), John Norse (M), Ronald Stanley Oberst (M), Fred H. Rohr, Jr. (A).

Southern California Section

Geo. R. Aldrich (M), John F. Beach (M), Robert John Cooper (M), William H. Devenport (A), Edward Walter Fredrick, Jr. (J), Lewis H. Garrett (A), Joseph B. Hunt (A), William C. Hurd (A), L. A. Lesovsky (M), G. S. Massa (M), Ralph Robert Roesky (J), Richard W. Sellwood (A), J. Robert Southland (M), Wilfred F. Talbot (M), Ivan Viets (M).

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New Members Qualified

continued

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Joseph Henry Lareau (M), Robert Hedges White (M).

Syracuse Section

John Norris Hepworth (J), Erving W. Parry (M), William B. Pashkow (M).

Texas Section

C. V. Bowman (M), Don H. Holbrook (M), Robert J. Williams, Jr. (J).

Texas Gulf Coast Section

E. L. Cranford (A), Edward A. Garner (M).

Twin City Section

Howard W. Carlsen (M), Melvin F. Diels (J).

Virginia Section

J. Harry Matthews (A), Harold A. Weisman, Jr. (A).

Washington Section

Edson L. Barlow, Jr. (J), Hal C. Farrell (A), Charles Pierpont Hoffmann, Jr. (M), Arthur H. Nuesse (A), John Cyril Knowles Shipp (M), Donald H. Tsai (M).

Western Michigan Section

Donald C. Gilbert (J).

Wichita Section

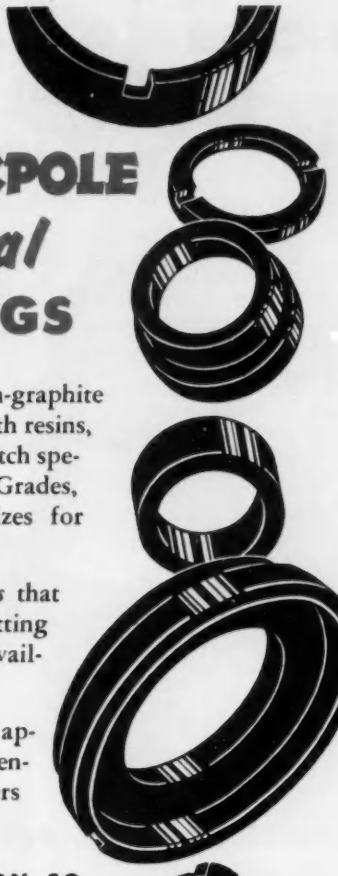
A. S. Odevseff (M).

Outside Section

Lewis M. Hough (J), James W. Humphrey (A), W. Curtis Miller (M), Stuart D. Pool (M), Carl Spangenberg (A), Kenneth E. Tibbits (M).

Foreign Section

Necati Anameric (A), Turkey; Rozendo deSouza (A), India; Dr. Hassan Mohamed El-Sabilgi (M), Egypt; Albert Leslie Gatiss (M), England; Hans Heinrich (M), Germany; Nils Ake Jonson (M), Sweden; 2nd Lt. M. R. Lakshmi Narasimhan (J), India; Eric Edward Read (M), New Zealand; Ivor Harold Smart (J), England.



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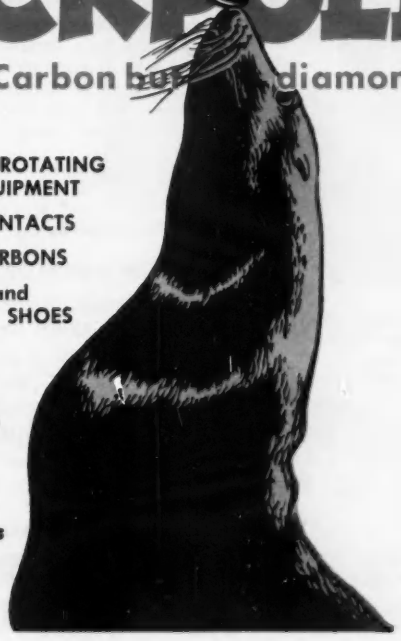

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Applications Received

The applications for membership received between May 10, 1954 and June 10, 1954 are listed below.

British Columbia Section

George Albert Cotton, William W. Wharton.

Buffalo Section

Marshall H. Brown, Clement William Cowley, Robert E. Lenz.

Canadian Section

William A. Coda, James Grant Dykes, Robert Allan Lane, Joseph James Walker Morrison, Edward Carl Pecheniuk, Joseph Thompson Purvis, Frank Donald Shaw.

Central Illinois Section

Neil S. Callbeck.

Chicago Section

Fred A. Brown, William J. Darley, Leonard H. Gerin, David E. Gow, Rader O. Hale, John W. Hancock, Thomas P. Hurst, Osborn A. Kershner, Michael Lenard, Richard H. Powell, Norman Carl Schumacher, Joseph Thomas Vidmar.

Cincinnati Section

Hugh F. Huggin, F. P. Waldmann, Joseph O. Young.

Cleveland Section

John L. Allen, Donald F. Collins, Ernest H. Dawson, E. Mandell deWindt, Albert R. Galasso, Robert C. Gannett, Charles A. Griggs, Glen Michael Hotz, Richard Joseph Kern, Russell F. Klatt, Lester Murray, Richard B. Robinson, Elverton O. Roe, Harold Edward Thomas.

Detroit Section

Robert H. Bauer, Albert C. Belge, William Allen Elston, Calvin S. Falk, Robert Millard Fenkell, Ralph K. Frey, Russell Bernard Hebert, Virgil A. Heck, Lyle Hoard, Jesse B. Howard, Ivan R. Johnson, Jack Allan Kerns, Harold M. Kimball, John W. Lester, Thomas E. Lohr, Ernest J. Massard, Calvin K. Miller, Jack E. Morgan, Joseph Michael Nunez, William Paul Panny, Fred Pradko, George Ralich, Mario P. Vano, Melvin F. Veitengruber, Charles Henry Wade.

Hawaii Section

Walter H. Grasser.

Indiana Section

Paul M. McLear, Gordon J. Parsons, Clarence J. Stultz.

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Applications Received

continued

Kansas City Section

Frederk T. Weisman.

Metropolitan Section

John S. Andrews, Daniel Berlin, Casimir Biebers, Robert Dagna, Otto H. Fedor, William C. Goodwine, Ernest E. Heins, John E. Keane, John I. Nestel, Ledyard H. Pfund, Harvey David Prace, Thomas P. Reilly, Jr., Howard Alan Rosenberg, James M. Ryan, Frank Schumann, Arthur S. Schutzer, Harold Sydnor, George A. Thompson.

Mid-Continent Section

John J. Casey, Jr.

Mid-Michigan Section

Verlin P. Miller.

Milwaukee Section

Robert G. Jensen, George Thomas Miller, Harry C. Probst, Eugene John Shermeister, Max B. Shipley.

Mohawk-Hudson Group

Donald I. Evans, Jr., John Allan Quiggle, Jr.

Montreal Section

John G. Brown, Theodore Couture, Victor Charles Korcz, J. M. Marceau.

New England Section

Edward P. Edmunds, Thomas E. Franks, Harold T. Hokanson, Horace C. Humphrey, Hal B. Stetson, Vincent G. Terry, Jr.

Northern California Section

Gail Hugh Allison, Frank George Avitia, George Condrashoff, Vincent Daniel Franger, Peter H. Hertel, John W. Humfreville, Walter Mayer, Ronald E. Sorenson.

Northwest Section

Richard H. Smith.

Oregon Section

Leo Jack German, H. Gordon Green.

Philadelphia Section

Harold Earl Beegle, Sol Berman, Howard W. Carr, Homer P. Coffin, Donald M. Davis, Frank J. Heymann, Frank Pichon, Edwin E. Ritter, Robert H. Thena.

Pittsburgh Section

Albert B. Baxter, Robert A. Stough, Robert Varga.

St. Louis Section

Bert James Bartlett.

Applications Received

continued

Salt Lake Group

Ernest D. Bunderson.

San Diego Section

Waldon W. Schmidt.

Southern California Section

Chester A. Barrand, Lloyd W. Bartlett, Vernon C. Brown, Leslie M. Davis, Richard K. Dovey, Conrad M. Fritz, Claude W. Hess, Frank Hetzel, Bernard R. Heymann, William F. Holtschulte, George Charles Kouris, William H. McClelland, Alden P. Perry, Henry W. Upton, Kenneth H. White, Raymond A. Young.

Southern New England Section

Ayden Cansever, Buel David Dean, Paul R. Glazier, Donald George Hall, William Thomas Hegenberger, Donald F. Kehn, Ray Robbins.

Syracuse Section

Maurice Fitzgerald.

Texas Section

J. R. Clark.

Texas Gulf Coast Section

Richard Van Alexander, Norvel Killion, Melbourne M. Martin, Jr., Bobby Joe Warren.

Twin City Section

Kenneth J. Miller, Orwin C. Youngquist.

Virginia Section

Joseph William Sickinger, W. P. Bernard.

Washington Section

D. Barry Boyce, Alfred O. Luning, Edward S. Taub, George William Wagner.

Western Michigan Section

Harry Leon Stryker.

Outside of Section Territory

Richard S. Clement, James Edward Gause, Howell C. Lowe, Keith A. Magalsky, John E. Mathews, Roberts Plank McCrea, Gerald A. Stoltenberg, Fred W. Walker.

Foreign

Charles Apert, France; Nicolas George Baz, Lebanon; Jose Higinio Monserrat, Argentina; M. A. Raouf, Pakistan.

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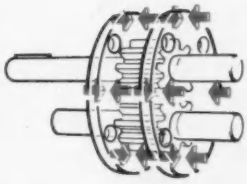
Oil Power

The famous HYDRECO Four-Bolt design Hydraulic Pump provides Oil Power on the John Deere No. 55 Self-Propelled Combine to position the Auger Platform and control the Variable Speed Drive. This model 1506 Pump delivers 3.3 gpm at 1200 rpm with pressures to 1500 psi... other models to 130 gpm.



Pressure Balanced wear plates maintain a fixed clearance between wear plates and gear faces regardless of pressure. This feature in HYDRECO Pumps and Motors minimizes oil slippage and power loss... volumetric efficiency and mechanical efficiency remain high!

Build the hydraulic circuit around the dependability of HYDRECO components. More and more design engineers find this premise leads to successful performance in service whether the application be farm equipment, machine tools, materials handling or construction machinery.

HYDRECO Oil Power . . . Pumps, Motors, Valves and Cylinders have one important characteristic in common . . . they're *dependable*. And the engineering that contributes this dependability may be relied upon to make significant contributions to your present and projected hydraulic problems.

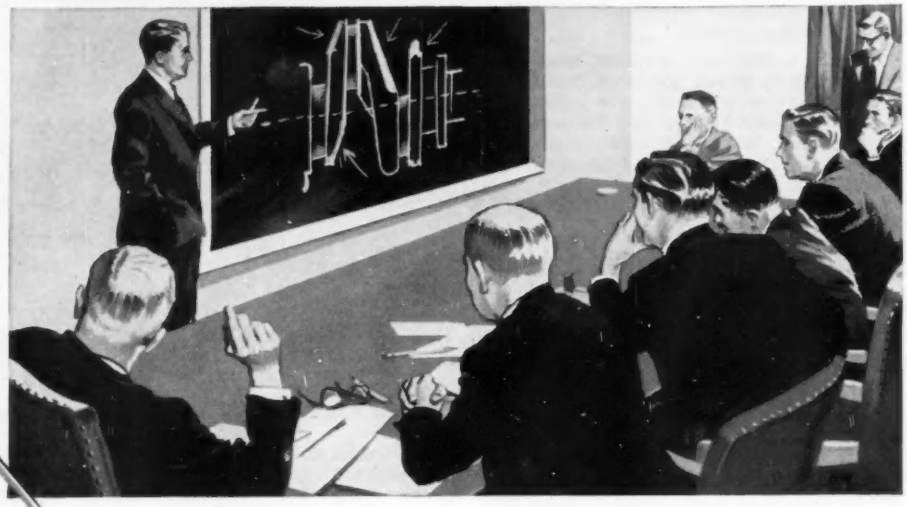
Write for brochures on HYDRECO Pumps, Motors, Valves and Cylinders.

HYDRECO DIVISION

THE NEW YORK AIR BRAKE COMPANY

1101 EAST 222nd STREET • CLEVELAND 17 • OHIO

moraine engineering



WHERE THE 'IMPOSSIBLE' BECOMES THE PRACTICAL

The "impossible" often proves to be not only *possible* but *practical* at Moraine, where engineers have a habit of thinking into the future and anticipating the solutions to customer problems. From this practice of looking ahead have come many important developments by Moraine for the automotive and other industries. Moraine engineering supplies the imagination, initiative and know-how needed to produce newer, better and more economical ways of interpreting the ideas of the modern designer.

Certain cars with power brakes needed a safety feature that would maintain reserve power for braking. Moraine provides that reserve power—an electrically driven vacuum booster pump that maintains an adequate vacuum reserve.

Moraine friction materials, able to withstand great heat and friction, are widely used in Powerglide, Hydra-Matic and Dynaflow automatic transmissions. Their use has spread to other applications . . . from military vehicles to home appliances.

From the truck and bus fields came a request for a tougher bearing to meet the severe requirements of heavy-duty engines. Moraine came up with the answer in the Moraine-400, the *toughest automotive engine bearing ever made!*

Manufacturers are learning that Moraine, through its broad metal-working experience and constructive attitude, has provided a solid foundation for the use of metal powder parts in industry. Every day, Moraine proves "It *can* be done!"

THESE PRODUCTS, TOO, ARE MORAINE

Moraine-100 engine bearings . . . Durex gasoline filters . . . Moraine porous metal parts . . . Delco hydraulic brake fluids . . . Delco master cylinders, wheel cylinders and parts . . . Moraine conventional engine bearings and electric motor bearings.

moraine products

DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

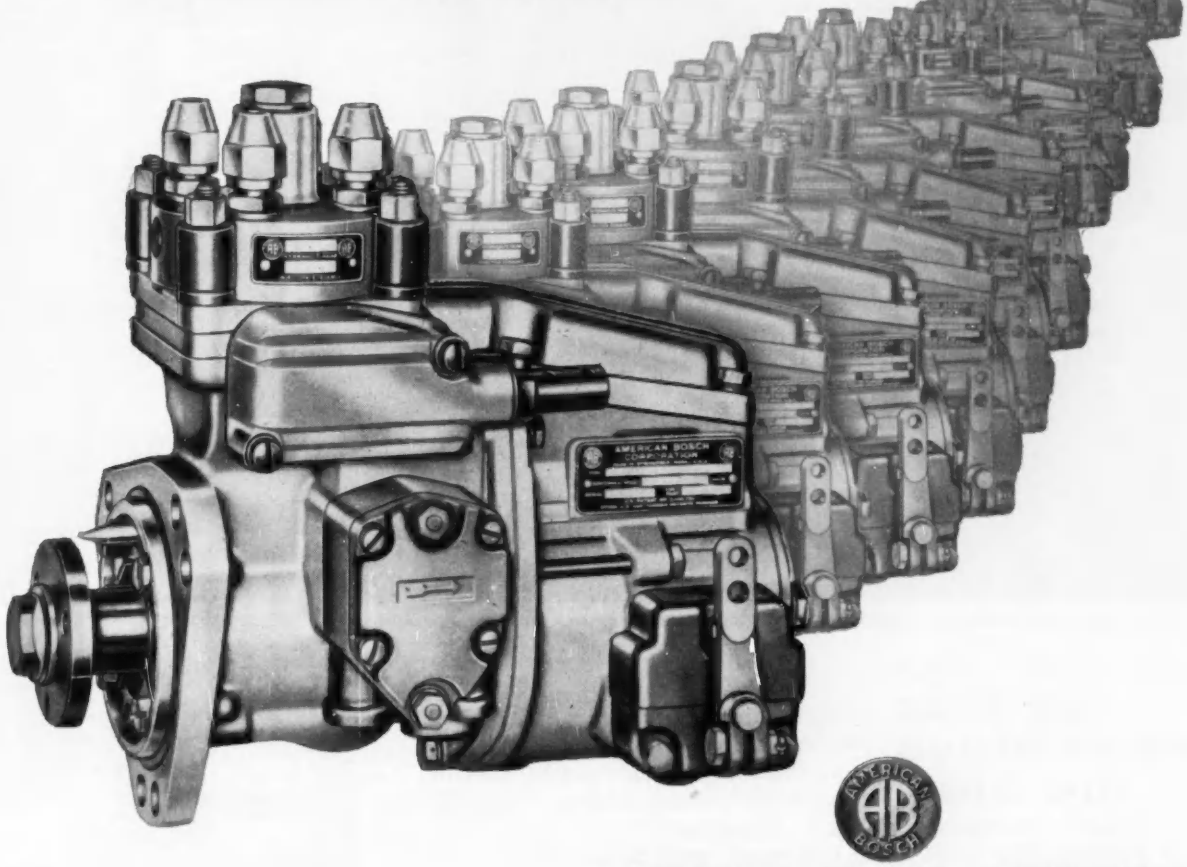
over 60,000 . . . and STILL GROWING

Over 60,000 American Bosch PSB single-plunger distributor-type Diesel fuel injection pumps have been produced since the pump was introduced several years ago.

Today, this simplified, lower-cost pump is being produced at a greater rate than ever before.

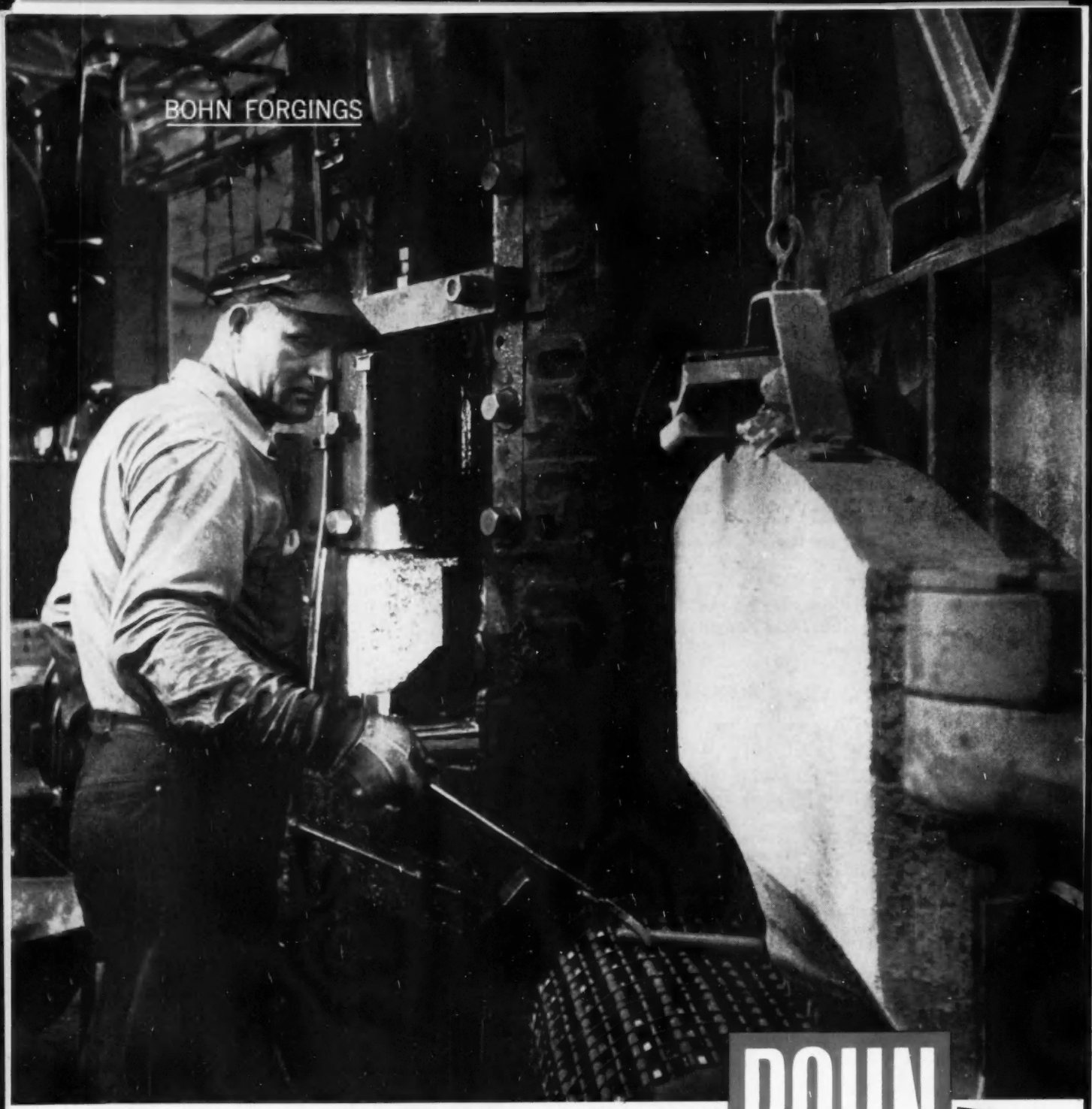
Here's definite proof of the acceptance of the PSB. It has literally revolutionized the concepts of fuel injection and made possible smaller, lower-cost Diesel engines . . . opening up new markets for Diesel power such as the farm tractor.

Tried and proved in the severest service, the PSB has rolled up remarkable records of performance—requires less maintenance—is easily serviced in the field. No wonder it has been hailed throughout the industry for its great contribution to Diesel progress.
American Bosch Corporation, Springfield 7, Mass.



AMERICAN BOSCH

2402



A BRASS SLUG IS LIFTED FROM THE FORGING FURNACE. ONE BLOW OF THE PRESS FORGES A COMPLETE REFRIGERATOR DOOR HANDLE

the slug determines the blow

Bohn's aluminum and brass forging division works closely with the extrusion division. Often an extrusion can be specially designed to simplify forging. When this shape is cut into forging "slugs", the operations on a given job are reduced. This helps Bohn customers lower costs without sacrificing quality. One more reason why it pays *you* to call on Bohn.

FORGINGS • BRASS ROD • EXTRUSIONS • INGOTS • CASTINGS • PISTONS • BEARINGS • REFRIGERATION AND AIR CONDITIONING PRODUCTS

Sales Offices: Boston, Chicago, Cleveland, Dayton, Detroit, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, Rochester, St. Louis

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ALUMINUM & BRASS CORPORATION

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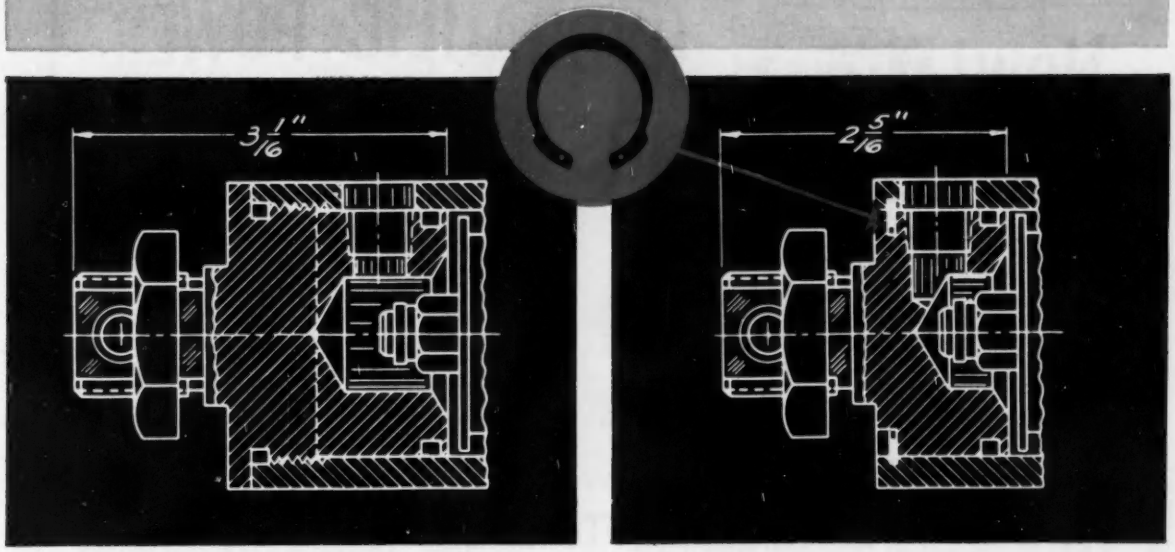
DETROIT 26, MICHIGAN

NEW BOOKLET
"Bohn Products and How They are Made."
Write for free copy of this pictorial tour through Bohn plants.

Waldes Truarc Rings Cut Costs $3.26 per Unit, Reduce Size and Weight of Air Cylinder!



OLD STYLE air cylinder, with thread-secured head, required costly tapping, chasing and assembly operations. Also, satisfactory maintenance of packing unit necessitated use of pipe wrenches on painted surfaces.

NEW cylinder head is secured with precision-ground Waldes Truarc Rings. This produces perfect alignment of head within the housing, difficult to obtain with screw-thread seating. Maintenance is quick and easy.

WALDES TRUARC RINGS PERMITTED THESE SAVINGS

Production Time Cut..17 minutes
Weight Saved.....1¾ lb.
Length Shortened.....1½ inches
Cost Saved.....$3.26 unit

■ The A. K. Allen Company of Brooklyn, New York, maker of *AllenAir* cylinders, now uses two Waldes Truarc Inverted Rings (series 5008) to secure heads rigidly within tubes.

■ TRUARC Rings, in this application, are ground parallel by A. K. Allen to .001 tolerance. In a static hydraulic bursting test, the 3" unit (recommended for 350 p.s.i.) withstands a pressure of 2000 p.s.i. And at bursting-point, the brass groove gives way; the Truarc Ring remains intact.

■ Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and to disassemble. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

■ Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool

SEND FOR NEW CATALOG

WALDES TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,765; 2,441,946; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,061; AND OTHER PATENTS PENDING.

SA 076

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name.....
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Company .....
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HYDRAULICS FOR MOBILE EQUIPMENT

VOL. 2

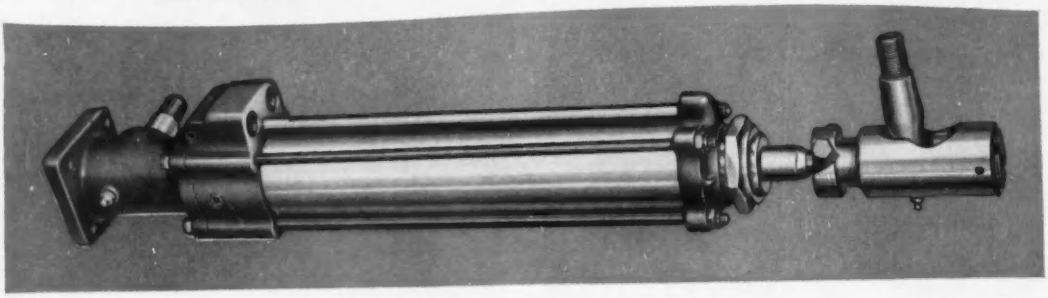
Mobile Equipment News

VICKERS INCORPORATED, DETROIT, MICHIGAN

IMPROVES PERFORMANCE • CUTS COSTS

NO. 5

New! VICKERS® HYDRAULIC POWER STEERING BOOSTER...SERIES S23



LATEST DEVELOPMENT in POWER STEERING for TRUCKS, BUSES, MATERIALS HANDLING VEHICLES, ROAD CONSTRUCTION and MINING MACHINERY

More compact . . . improved in operating characteristics . . . this new Vickers Steering Booster, Series S23 is an important new development in power steering for many vehicles. Application is much easier because it requires less space . . . and ultimate costs are substantially lower. Series S23 thus opens the way to fingertip ease of steering for a wide range of additional vehicles.

Like the preceding models, Series S23 has hydraulic lock against road shock. Bumps, chuckholes, blown front tires, obstructions, etc., cannot spin the steering wheel or jerk it out of control. This is a safety factor of great importance.

In the interest of better operation and as a logical design improvement, the integral relief valve has been omitted from Series S23 and combined with a volume control valve. Vickers VT16 and VT17 pumps have integral volume control and relief valves. Where larger pumps are required, a separate combination valve is used (see Series FM2 below).

ASK FOR NEW BULLETIN M5106

MORE VERSATILE INSTALLATION

In Series S23 Boosters, the servo ball stud housing is symmetrical, and can be assembled in any one of four positions. This and the compactness of the Booster makes application easier . . . increases the number of applications which can be made without major engineering changes. Series S23 Booster may be mounted interchangeably with Series S6-270 Booster, however a relief valve must be provided either by use of VT16 or VT17 pumps or Series FM2 volume control and overload relief valve.

REQUIRES LESS SPACE

The new booster has been reduced in size by the redesign of the servo control valve. The tube connecting the servo valve to the rod end has been relocated and is now on the same side as the fitting connection. As a result of these changes, Series S23 requires less space . . . works in closer quarters.

6795

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

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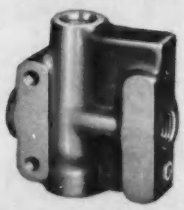
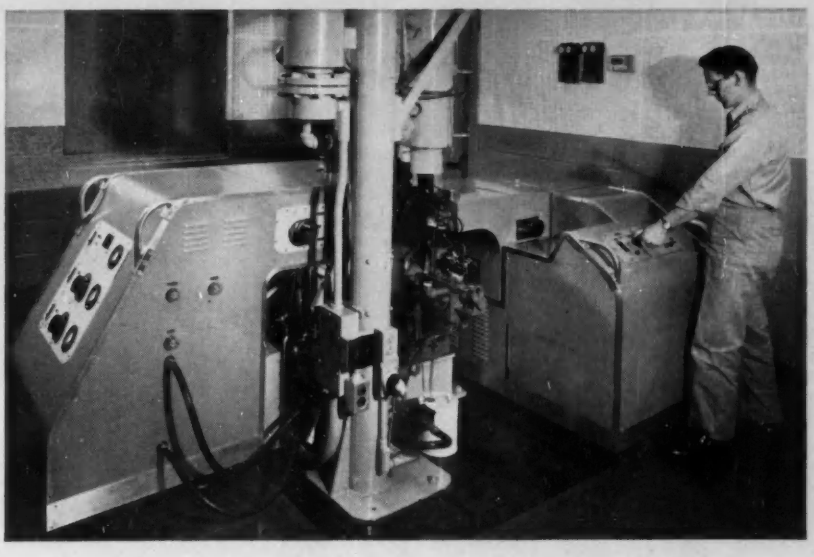
VICKERS® VOLUME CONTROL and OVERLOAD RELIEF VALVE



Five sizes of Series FM2 Valves were developed primarily for hydraulic power steering on trucks, buses and materials handling equipment where the pump does not include a volume control valve. The FM2 improves steering booster performance by providing a relatively constant volume of oil regardless of engine speed variations. An integral relief valve is included.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



The Du Pont Petroleum Laboratory's spectrometer for studying knock. The operator is shown adjusting the amplifier for recording. Part of the single-cylinder engine can be seen in the center of the picture.

Unique spectrometer being used to develop new facts about KNOCK

Combustion chamber reactions which contribute to knock have long eluded accurate analysis.

But now, these important, but little understood reactions may be revealed by the spectrometer shown here, which is installed at the Du Pont Petroleum Laboratory.

With this spectrometer, laboratory scientists are taking a new look at the old problem of finding out exactly what goes on in the combustion chamber when a gasoline and air mixture is compressed.

Spectral Analysis

The apparatus is built around a single-cylinder engine having windows on opposite sides of the combustion chamber. Light is passed through the chamber from a source which is located at the left in the picture above. After being filtered through the partially reacted fuel-air mixture, the remaining light rays pass through a multiprism, optical system and are converted into electrical impulses for automatic recording on a strip chart. This spectral analysis covers the complete range of ultraviolet, visible and infrared light.

Since each chemical reaction in the chamber has a characteristic light absorption pattern, the spectrometer can be used to make an analysis of the rapid chemical changes taking place within the chamber. In this way, reactions leading to knock can be followed in the engine and analyzed in detail.

An important part of the equipment is the shutter which is synchronized with the engine crankshaft. This shutter allows light from the combustion chamber to enter the spectrometer only during that part of the engine cycle which is being studied.

What and How

This unique spectrometer, the only one of its kind, was specially developed for the Du Pont Petroleum Laboratory to study exactly *what* causes knock and *how* tetraethyl lead reacts in the fuel to prevent it. Once the answers to these questions have been found, they may point the way to new methods of suppressing knock. After the results of this work have been analyzed, they will be published and made available to the automotive and petroleum industries.

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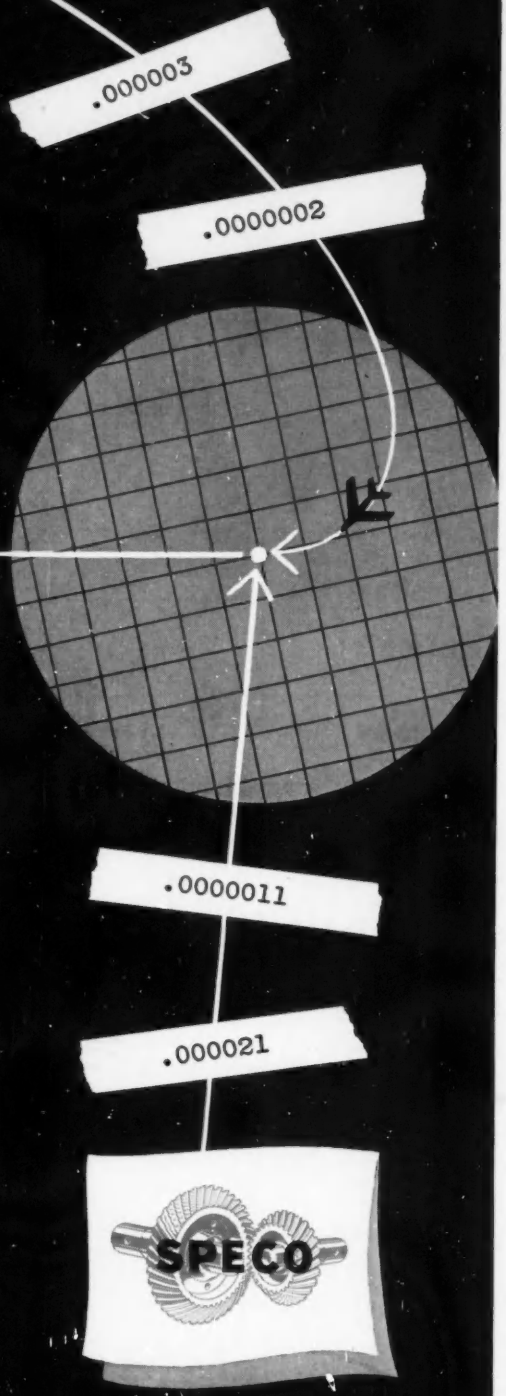
How many places

east of the decimal point?



• We haven't yet found this on a drawing but . . . on a bombing or computing gunsight, an almost infinitesimal decimal error in the device itself, may well be multiplied to hundreds of yards, at the target area.

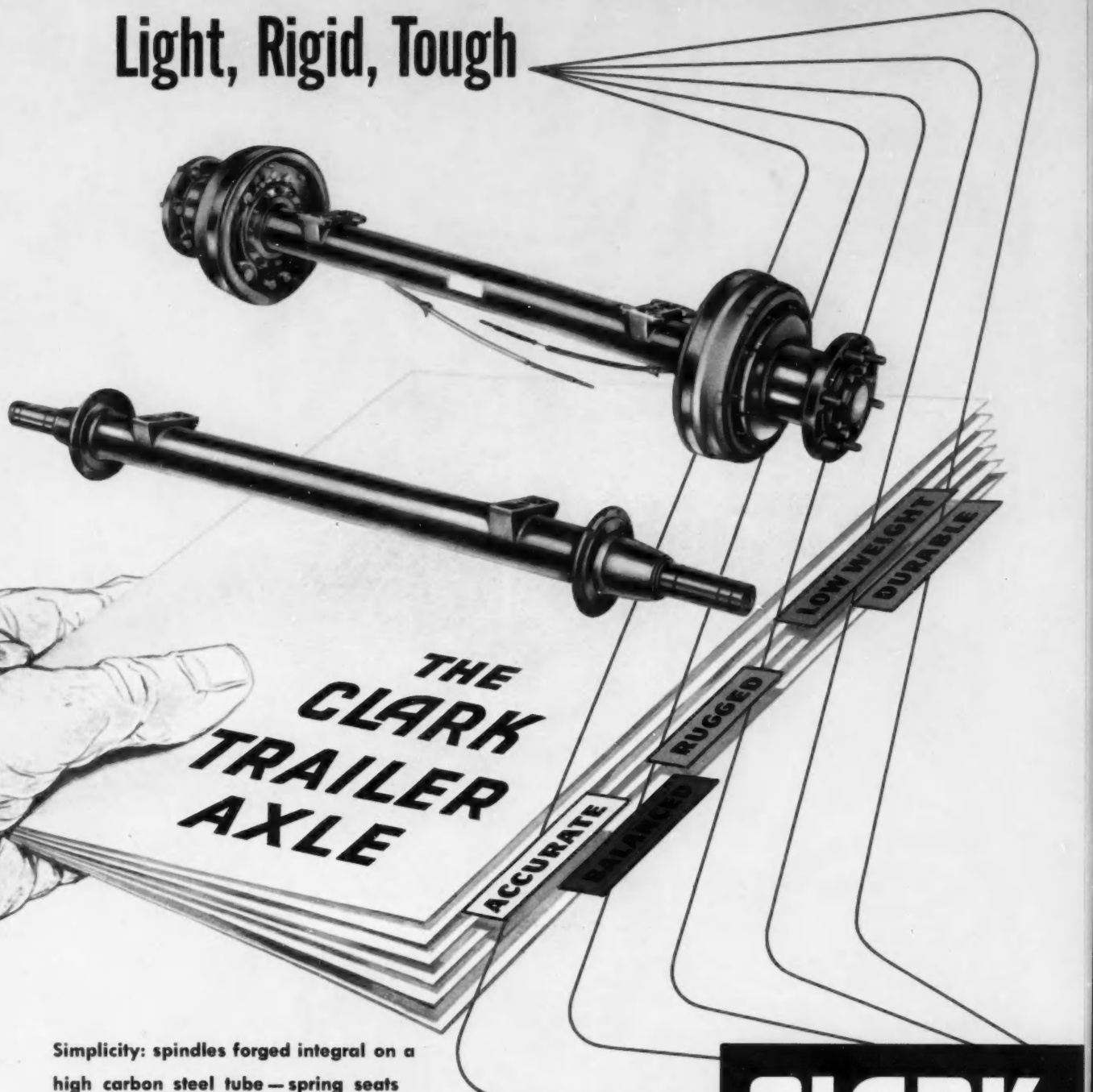
We help forestall such errors and results by producing gear assemblies of the utmost precision . . . for computers, for accessory drive units, actuators, transmissions and controls. We also produce precision components such as bomb hoists, gun turrets, radar tracking and scanning assemblies.

Bring us your development and production problems, large or small. Our long, proven experience can solve them. A letter or telephone call will put us at your service.

THE STEEL PRODUCTS ENGINEERING CO.

ENGINEERS AND MANUFACTURERS • SPRINGFIELD, OHIO

Light, Rigid, Tough



THE CLARK TRAILER AXLE

Simplicity: spindles forged integral on a high carbon steel tube — spring seats and brake mountings welded in place — and the complete unit heat-treated. Result: an axle of light weight, rigidity, extraordinary toughness and one more convincer that it's good business to do business with CLARK.

CLARK EQUIPMENT

CLARK EQUIPMENT COMPANY, BUCHANAN, Battle Creek, Jackson, Benton Harbor, Michigan

Lakey Foundry saves 112 man-hours per shift in core handling with three 2000-lb. Clarks

Handling finished cores, from baking ovens either to core storage or direct to the molding line used to require 23 men using hand dollies; and stacking was done manually. Now, says Jim Wilson, Methods Engineer, three operators on Clark 2000-lb. trucks with six helpers, do a far better job with a reduction of 112 man-hours per 8-hour shift. "That's nice money!" is Jim Wilson's understatement.

Foundries are a particularly "happy hunting ground" for cost-minded executives armed with Clark fork trucks: on the alert for faster, safer, cheaper ways to handle sand, scrap, cores, molds, castings—all the many handling jobs that make up a foundry's production cycle.

How about some good hunting in your own plant?

There's an expert guide available—the Clark dealer: thoroughly competent to analyze your materials handling needs and to devise a plan to satisfy them. He's listed in your directory's Yellow Pages.

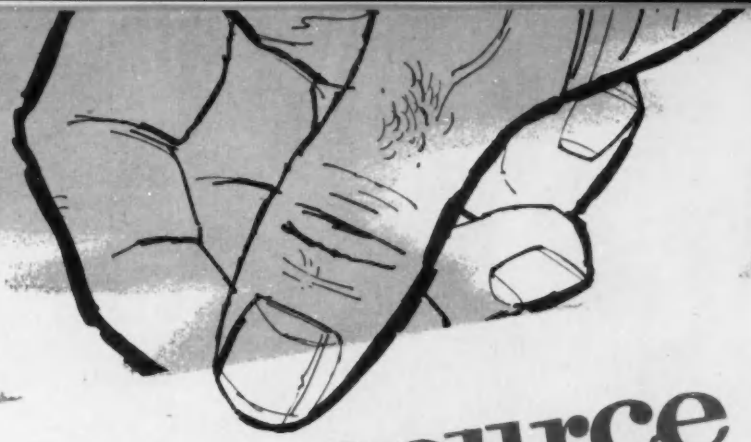
HOW LAKEY USES THREE CLARK TRUCKS

Production:	10,000 cores per day from 4 core lines and 4 ovens; grey iron castings chiefly for engine blocks and housings for industrial, agricultural and earth-moving machinery.
Sizes & Wts.:	10"-30" high, cores 12 to 100 lbs. each.
Handling Equipment:	3 Clark 2000-lb. trucks, 36" x 48" plywood and metal pallets, hydraulic load stabilizers with 1" sponge-rubber facing, to hold cores firmly and compensate for varying heights.
Unit Loads:	Range from 800 lbs. to 1600 lbs.
Storage:	Palletized units tiered to 15 ft. height; neat rows conserve storage space, simplify removal of cores, promote good-housekeeping.

PRODUCTS OF CLARK: TRANSMISSIONS • DRIVING AND STEERING AXLES • AXLE HOUSINGS • TRACTOR DRIVES • LIFT TRUCKS • TOWING TRACTORS • ROSS CARRIERS • POWRWORKER HAND TRUCKS • EXCAVATOR CRANES • TRACTOR SHOVELS • ELECTRIC STEEL CASTINGS • GEARS AND FORGINGS

CLARK EQUIPMENT

Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek, Michigan



one source

FOR INTRICATE CASTINGS

gray iron or steel... any quantity... for any purpose

The long experience of Campbell, Wyant and Cannon has led to the development of many outstanding techniques for the production of intricate parts for nearly every industry. Shown here are a few of the many castings produced by CWC that are the result of highly advanced metallurgical engineering, precision control and mechanization.

From CWC's cupolas, electric furnaces, converters and heat-treating ovens come much of what's new and better in castings. Whatever *your* needs, CWC can meet your requirements for quantity, quality and economy . . . intricate castings—or general purpose, steel castings, castings with special properties, heat-treated or centrifugal castings. Let CWC serve you now . . . you cannot find more complete facilities at one source anywhere!

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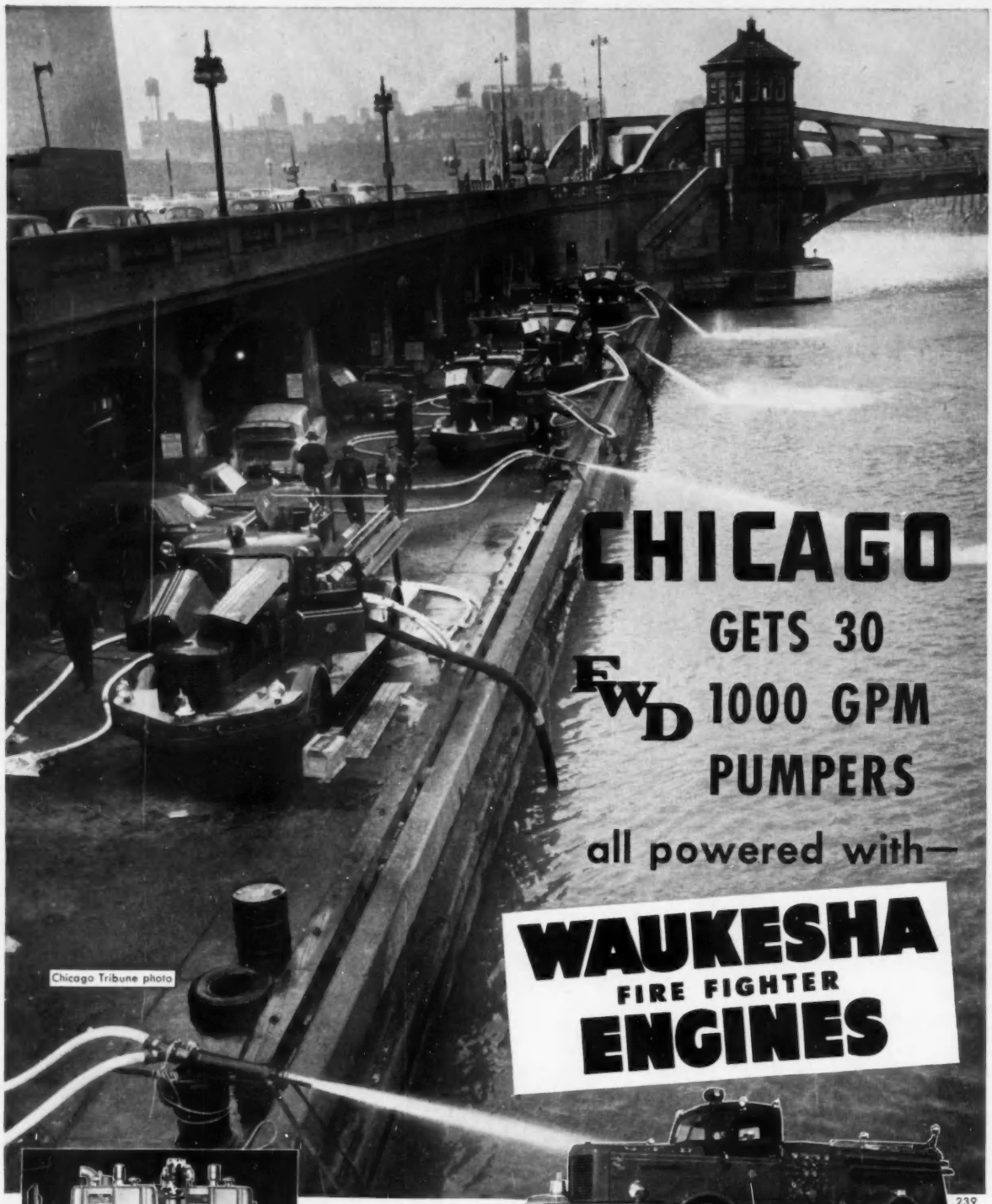
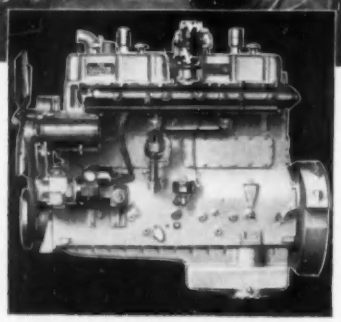


CHICAGO GETS 30 FWD 1000 GPM PUMPERS all powered with—

WAUKESHA FIRE FIGHTER ENGINES

Chicago Tribune photo



WAUKESHA 145 GKB High Output FIRE FIGHTER Engine, 6-cylinders, 5¼ in. x 6 in., 779 cu. in. 240 hp. @ 2400 rpm. counterbalanced, vibration dampened. 3½ in. 7-bearing hardened crankshaft, dual ignition, precision bearings, overhead valves with Stellite-faced exhaust valves and seats, removable wet sleeve cylinders. Get Bulletin 1594.

239

FWD Pumper, Model F-1000-T, equipped with Waterous CD-3 two-stage centrifugal pump. Powered with Waukesha 145 GKB High Output Fire Fighter engine, arranged for full electrical equipment and all modern accessories.

WAUKESHA MOTOR COMPANY, Waukesha, Wis.
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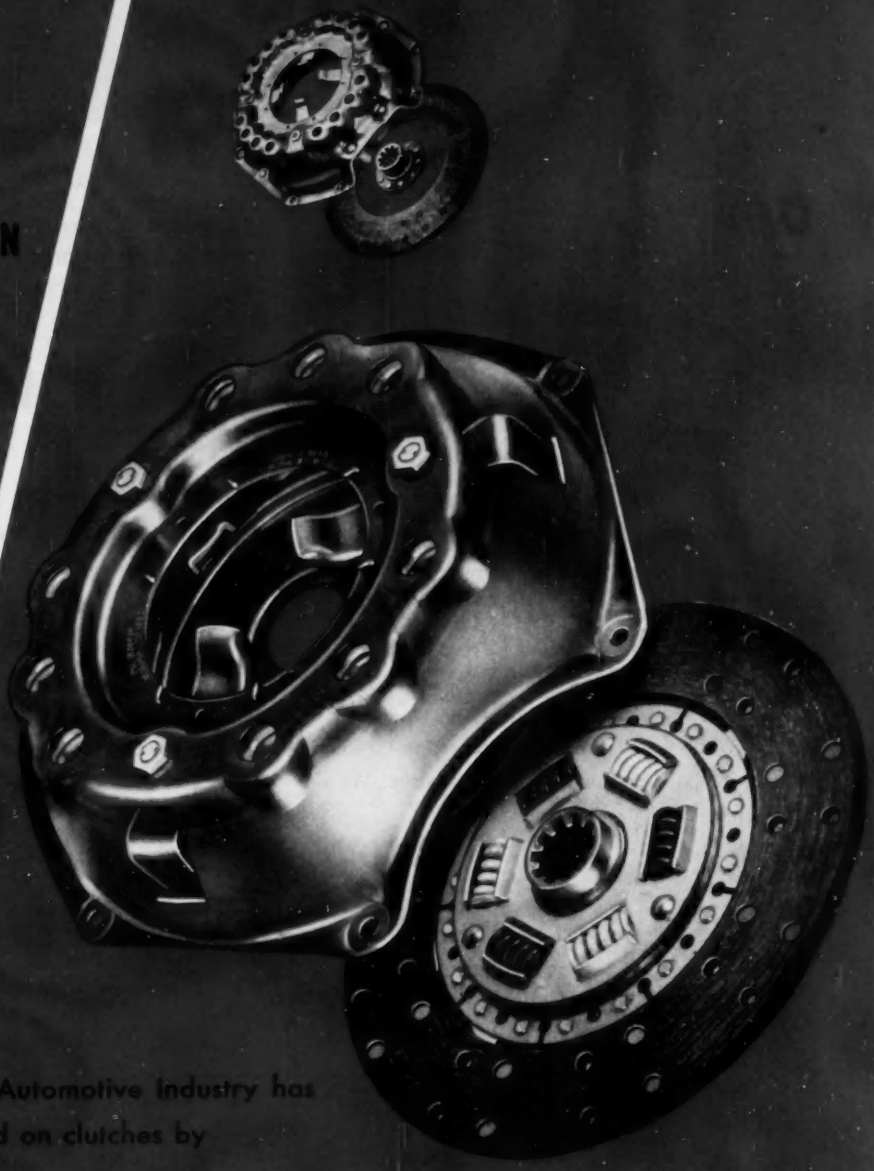
BETTER SERVICE

LONGER LIFE



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For that vital spot where Power takes hold of the load!

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The Standard Clutch—A Product of Borg-Warner

BORG & BECK Division

ENGINEERING B-W PRODUCTION

Borg-Warner Corporation
Chicago, Illinois

Because contractors measure fast, sure starts in dollars...

P&H uses GLOBE batteries

... it's added evidence that Globe batteries help insure better starting for automotive equipment

A reputation for quick starting adds considerably to overall sales appeal of petroleum-powered equipment.

This Harnischfeger P&H 955-A crawler-crane with lifting capacities up to 70 tons uses a Globe battery. As a result, it enjoys a reputation for fast, sure starting that owners can actually measure in terms of increased output or profits.

Globe-built batteries for automotive equipment feature many of the same design and construction advantages. For the equipment you produce and sell specify Globe and be sure.

GLOBE-UNION INC.

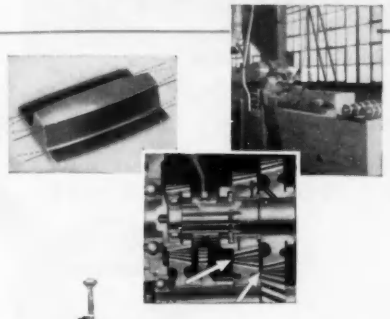
FOR FAST SERVICE, THERE ARE 15 GLOBE BATTERY PLANTS — ATLANTA, GEORGIA • BOSTON, MASS. • CINCINNATI, OHIO • DALLAS, TEXAS • EMPORIA, KANSAS • HASTINGS-ON-HUDSON, NEW YORK • HOUSTON, TEXAS • LOS ANGELES, CALIFORNIA • MEMPHIS, TENN. • MILWAUKEE, WISCONSIN • MINERAL RIDGE, OHIO • OREGON CITY, OREGON • PHILADELPHIA, PENNSYLVANIA • REIDSVILLE, NORTH CAROLINA • AJAX (TORONTO) CANADA.

IF IT'S PETROLEUM-POWERED *there's a Globe-built battery... right from the start*

Why more and more truck manufacturers are shifting to FULLER

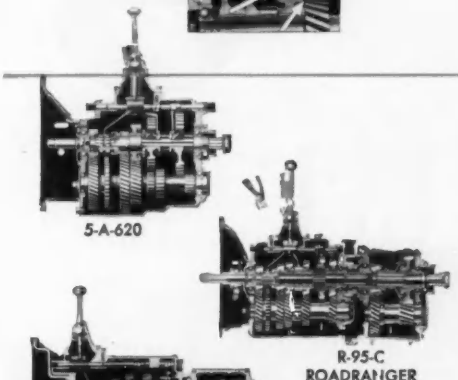
Demand from the field

Ask the driver—the man who has to maintain engine rpm to meet round-trip schedules. Ask the mechanic—the man who has to keep the truck *on the road.* Ask the owner—the man who has to pay the bill if the transmissions fail. They'll tell you they want a Fuller Transmission . . . *for Fuller has the features for more profitable trucking.*



Fuller design features

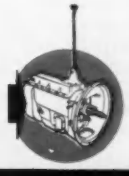
Open up a Fuller Transmission . . . and you can see the "extras" Fuller provides. Take a Fuller-equipped truck out on the road and *feel* it perform. Constant mesh, helical gears mean easier, faster shifting in forward speeds. Crowning the gear teeth prevents stress . . . longer life for Fullers. Shot peening reduces metal fatigue . . . less material failure.



110 Models—100 to 400 hp

Specify a Fuller Transmission for your on- or off-highway units and get a transmission *matched* to your load and road conditions . . . that will provide the right ratios for your job. Specify a transmission *designed to deliver* more effective horsepower . . . a Fuller Transmission.

where horsepower really goes to work



Fuller TRANSMISSIONS®

FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO, MICHIGAN

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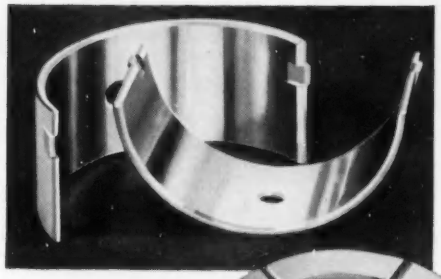
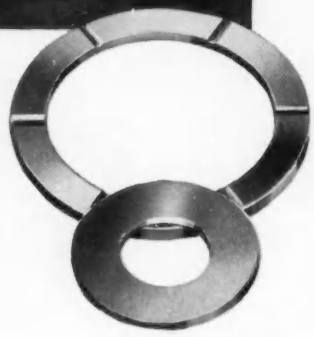
BRONZE·ON·STEEL

BOTH SURFACES





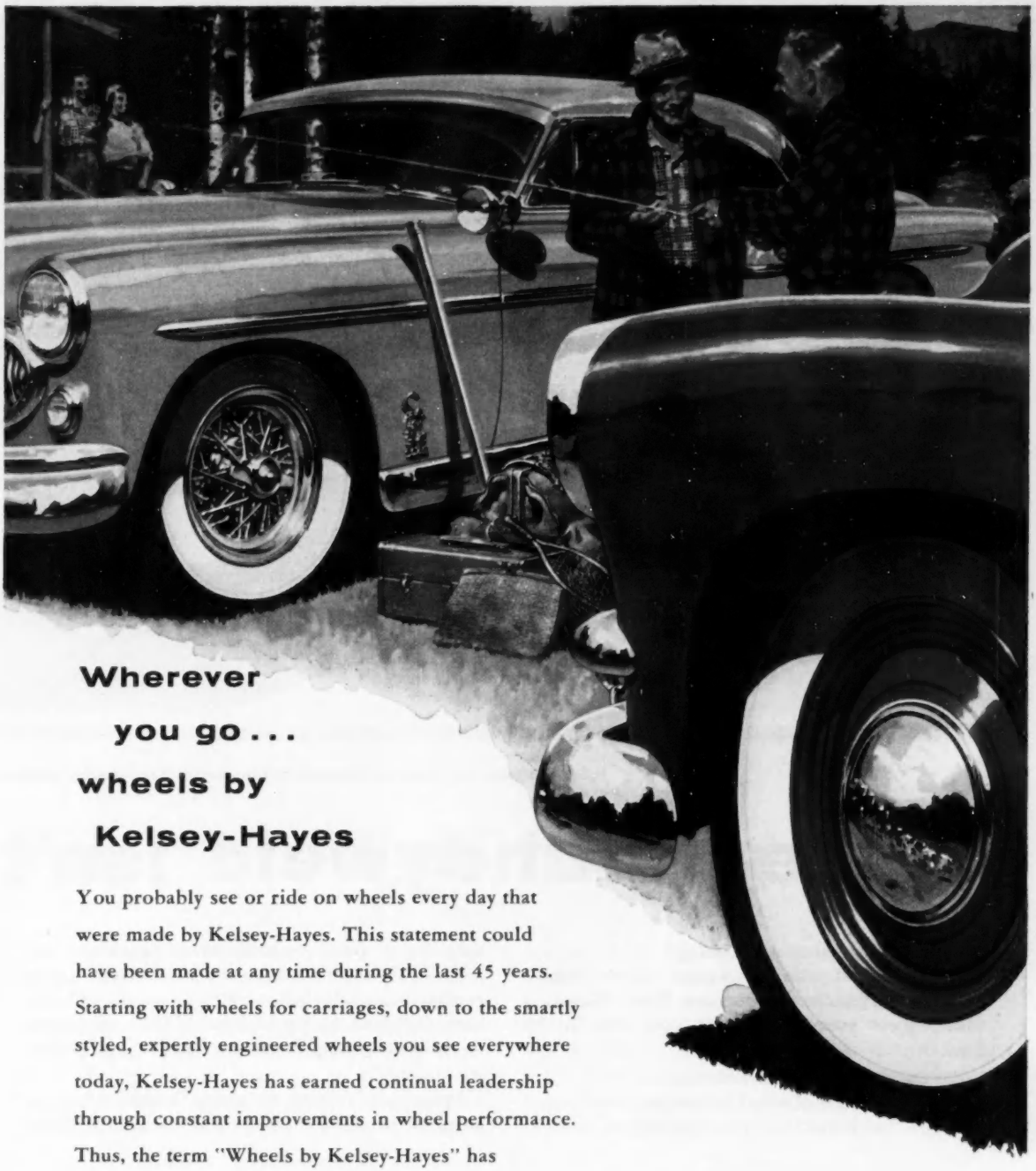
Where "two-side" bearing surfaces are required, Johnson Bronze-on-Steel is the answer. Floating connecting rod bearings often require this type of metal, also thrust washers. They are produced by bonding pre-cast bronze powder* to both sides of steel strip. This combines the fine bearing properties of copper-lead alloy with the strength and other properties of steel. This material is available in bearing form, or in strip form—rolls up to 400 feet or individual strips of any length for your own stamping or forming.

JOHNSON JB BEARINGS
Sleeve Type

* To assure complete laboratory control of quality from the ingot to the finished product, Johnson Bronze has built a new powder plant for the production of alloy type powders by a patented process of disintegrating and quenching molten alloys. Therefore, the correct alloy for a particular use can always be prepared to correct specifications. This is another reason why Johnson Bronze has become known as Sleeve Bearing Headquarters.

Write for information.

JOHNSON BRONZE COMPANY • 675 South Mill Street, New Castle, Pa.



Wherever you go . . . wheels by Kelsey-Hayes

You probably see or ride on wheels every day that were made by Kelsey-Hayes. This statement could have been made at any time during the last 45 years. Starting with wheels for carriages, down to the smartly styled, expertly engineered wheels you see everywhere today, Kelsey-Hayes has earned continual leadership through constant improvements in wheel performance. Thus, the term "Wheels by Kelsey-Hayes" has come to mean *wheels of the highest quality.*

Kelsey-Hayes Wheel Co., Detroit 32, Mich.

KELSEY HAYES

World's Largest Producer of Automotive Wheels

Wheels, Brakes, Hubs, Brake Drums, Special Parts for all Industry • 9 Plants—Detroit and Jackson, Mich. . . . McKeesport, Pa. . . . Los Angeles . . . Windsor, Ont., Canada . . . Davenport, Ia. (French & Hecht Farm Implement and Wheel Div).

For dependable oil, fuel and hydraulic brake lines in your trucks, trailers,

See if Bundyweld isn't

What do you need in your tubing?
Should it be leakproof, lightweight? Should it have high bursting point, high fatigue limit? Should it take almost every fabrication operation in the book?

What do you want from your tubing?
Want more peace of mind for yourself and everyone else connected with the production, sale, or servicing of your product? More peace of mind and satisfaction for your customers? Want tubing proved dependable in over 20 years of use in brake lines, fuel lines, hydraulic window lift lines, power-steering-connecting lines, instrument gauges, other applications?

Want your tubing in easily handled straight lengths—clean and ready for your production lines?

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

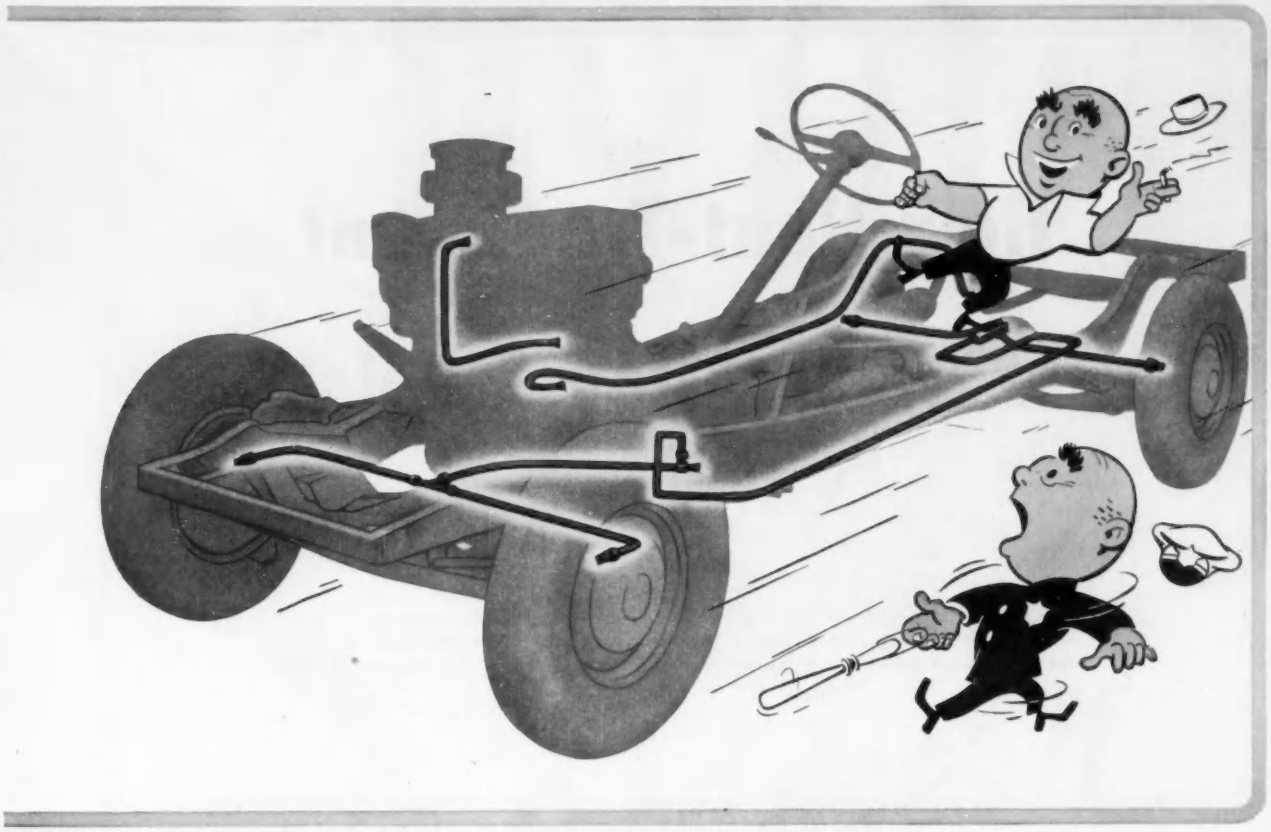
continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., East.
Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.



tractors or automobiles—come to Bundy, headquarters for automotive tubing.

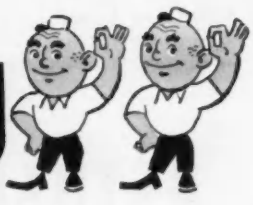
your kind of tubing

Or would you like it fabricated into the needed parts—exactly to your specifications? Want deliveries timed to exacting schedules and made as promised? Would you like to call in tubing specialists to work with you on design, fabrication, or function problems?

You'll find that Bundyweld Steel Tubing is your kind of tubing—the *only* tubing double-walled from a single strip, copper-bonded throughout 360° of double-wall contact. And you'll find that Bundy engineering and fabrication services are right to your liking, too. Call, wire or write us today for any details you'd like or for an appointment with a Bundy sales engineer for an exploratory talk.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN

Bundyweld® Tubing



DOUBLE-WALLED FROM A SINGLE STRIP

How Heat-Treatment Affects Alloy Steels

This is the fourth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

There are in general five different forms of heat-treatment used with hot-rolled alloy steel. These treatments modify the mechanical properties of the steel to suit the end use. Basically, heat-treating may be defined as an operation or series of operations involving the heating and cooling of steel in the solid state to develop the required properties.

The five forms of treatment mentioned above, as applied to constructional alloy steels, are discussed in the following paragraphs:

(1) QUENCHING AND TEMPERING usually consists of three successive operations: (a) heating the steel above the critical range, so that it approaches a uniform solid solution; (b) hardening the steel by quenching it in oil or water; and (c) tempering the steel by reheating it to a point below the critical range in order to effect the proper combination of strength and ductility.

(2) NORMALIZING is a form of treatment in which the steel is heated to a predetermined temperature above the critical range, after which it is cooled slowly to below that range in still air. The purpose of normalizing is to promote uniformity of structure and to alter mechanical properties.

(3) ANNEALING consists of heating the steel to a point at or near the critical range, then cooling at a predetermined rate. Annealing is used to develop softness in steel, to improve machinability, to reduce stresses, to improve or restore ductility, and to modify other properties.

(4) SPHEROIDIZE-ANNEALING is the prolonged heating of steel at an appropriate temperature, followed by slow cooling to produce a globular condition of the carbide. This treatment produces a structure which may be desirable for machining, cold-forming or cold-drawing, or for the effect it will have on subsequent heat-treatment.

(5) STRESS-RELIEVING is the process of reducing internal stresses by heating the steel to a temperature below the critical range and holding for a time interval sufficient to equalize the temperature throughout the piece. The object of this treatment is to restore the elastic properties of the steel, or to reduce stresses that may have been induced by machining, cold-working, or welding.

Bethlehem metallurgists have had long experience in all methods of heat-treating. They understand the possibilities and limitations of each method with respect to various alloy steels. These men will be glad to give advice or help you with any problems concerning heat-treatment. Always feel free to ask for their services.

And call on Bethlehem, too, for the full range of AISI standard alloy steels, as well as special-analysis steels and all carbon grades. We can meet your needs promptly.

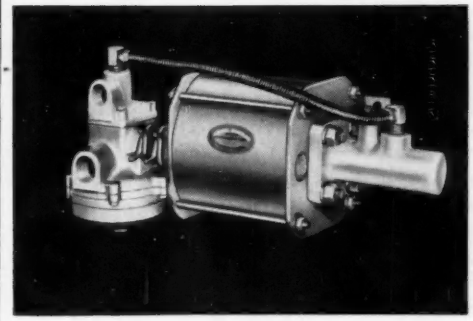
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM ALLOY STEELS

BETHLEHEM STEEL

Easy does it



with BORG-WARNER "FEATHER TOUCH" POWER BRAKES

Designed for Service Shop Installation on Most '46 to '54 Model Cars

By now, most car owners are aware of the many advantages of power brakes. Smooth, instant response to light pedal pressure . . . quicker, shorter, surer stops . . . less strain, less fatigue, greater driver comfort.

But up until recently, power brakes were available only as factory installed optional equipment on certain makes of new cars. Now—thanks to Borg-Warner engineering—B-W "Feather Touch" Power Brakes can be installed in an hour or so on most '46 to '54 models of all popular makes of cars.

As with scores of other Borg-Warner products, this new unit is engineered out of deep experience with the automotive industry's high standards. It has a minimum of wearing parts, requires no lubrication, is unaffected by changes in climate. And it is the industry's smallest, most compact unit, low in price, dependable in performance.

Designed and built by B-W's Marvel-Schebler Products Division, the new "Feather Touch" Power Brake is another example of Borg-Warner's "design it better—make it better" tradition. One more in a long list of B-W contributions to the driving safety, comfort and pleasure of the motoring public.

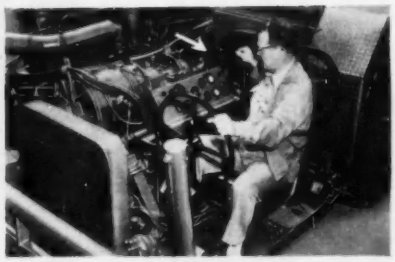
B-W *engineering makes it work* **B-W** *production makes it available*

ENGINEERING B-W PRODUCTION

Almost every American benefits every day from the 185 products made by

BORG-WARNER

THESE UNITS FORM BORG-WARNER, *Executive Offices, Chicago:* ATKINS SAW • BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • CLEVELAND COMMUTATOR • DETROIT GEAR • FRANKLIN STEEL • HYDRALINE PRODUCTS • INGERSOLL PRODUCTS • INGERSOLL STEEL • LONG MANUFACTURING • LONG MANUFACTURING CO., LTD. • MARBON • MARVEL-SCHEBLER PRODUCTS MECHANICS UNIVERSAL JOINT • MORSE CHAIN • MORSE CHAIN CO., LTD. • NORGE • PESCO PRODUCTS • REFLECTAL • ROCKFORD CLUTCH SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR • WARNER GEAR CO., LTD. • WOOSTER DIVISION



Here's the LOW DOWN on HIGH HEAT TRANSFER

High climbs up five miles or more of rugged road to the rim of an open-pit copper mine . . . with a 75-ton payload . . . generates lots of heat. When the Dart Truck Company built the giant 12-wheeled, 96,000 pound, truck for Bagdad Copper Mines, the design required the finest radiators and heat transfer products obtainable. As a result, Young Heat Exchangers and Young "Mono-Weld" Radiators were selected to do the cooling job. On Dart's 275 HP Underground Truck, Young was again specified.

Such is the story throughout many industries . . . wherever optimum engine cooling is required along with superior construction for rugged service. Whatever *your* heat transfer problem may be, take it up with a Young Sales Engineer. He will recommend a specific unit or combination of units to meet your specialized needs without obligation to you.

DART MOTOR Selects YOUNG Radiators and Exchangers

Top photo: "Aardvark" made by Dart for underground work. Only 60 inches high and fully reversing, it is ideal for work in mine tunnels. Conveyor discharges from 0 to 60 feet per minute. *Inset top:* Operator's "Office" puts all instruments and controls in easy reach. Excellent vision is possible in either direction. *Lower left photo:* Inset shows two Young Standard-type "Mono-Weld," welded steel, Radiators which cool 350 hp Diesel engine of the Dart 60 Truck shown alongside. Two Young Type "F" Heat Exchangers are used to cool the fluid for the twin torque converters.

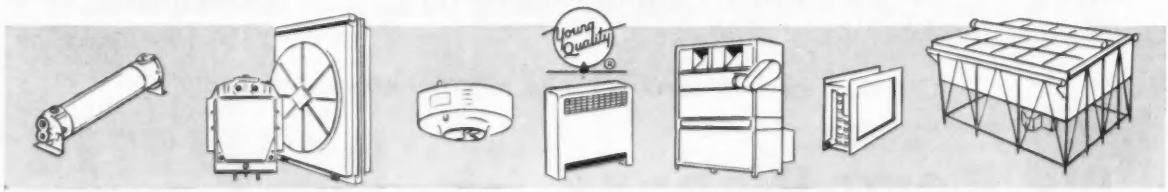
Write for further details or catalogs, without obligation.

Heat Transfer Products for Automotive, Agricultural, Industrial, Gas and Diesel Engine Application.

YOUNG

Heating, Cooling, Air Conditioning Products for Home and Industry.

YOUNG RADIATOR COMPANY DEPT. 114-G, RACINE, WISCONSIN • PLANTS AT RACINE, WIS. AND MATTOON, ILL.



Shell and Tube Heat Exchangers | Automotive and Industrial Radiators | Unit Heaters | Convector Radiators | "YAC" Air Conditioners | Heating and Cooling Coils | "HC" Cooling and Condensing Units

Only Eaton 2-Speed Axles have the money-saving features provided by Planetary Gearing

More than two million
Eaton Axles in trucks today!

With Eaton's exclusive planetary design, gear speeds are slower; gear loads are distributed over several gear teeth, holding down stresses and wear. Planetary pinions turn only in the low speed range. In the high speed range they are locked out. The axle then operates as a conventional single-reduction unit. Eaton 2-Speeds are quiet in operation, easy to shift, and run long, trouble-free mileages. Genuine dollars-and-cents savings for truckers are assured by actual performance records representing billions of miles of operation.

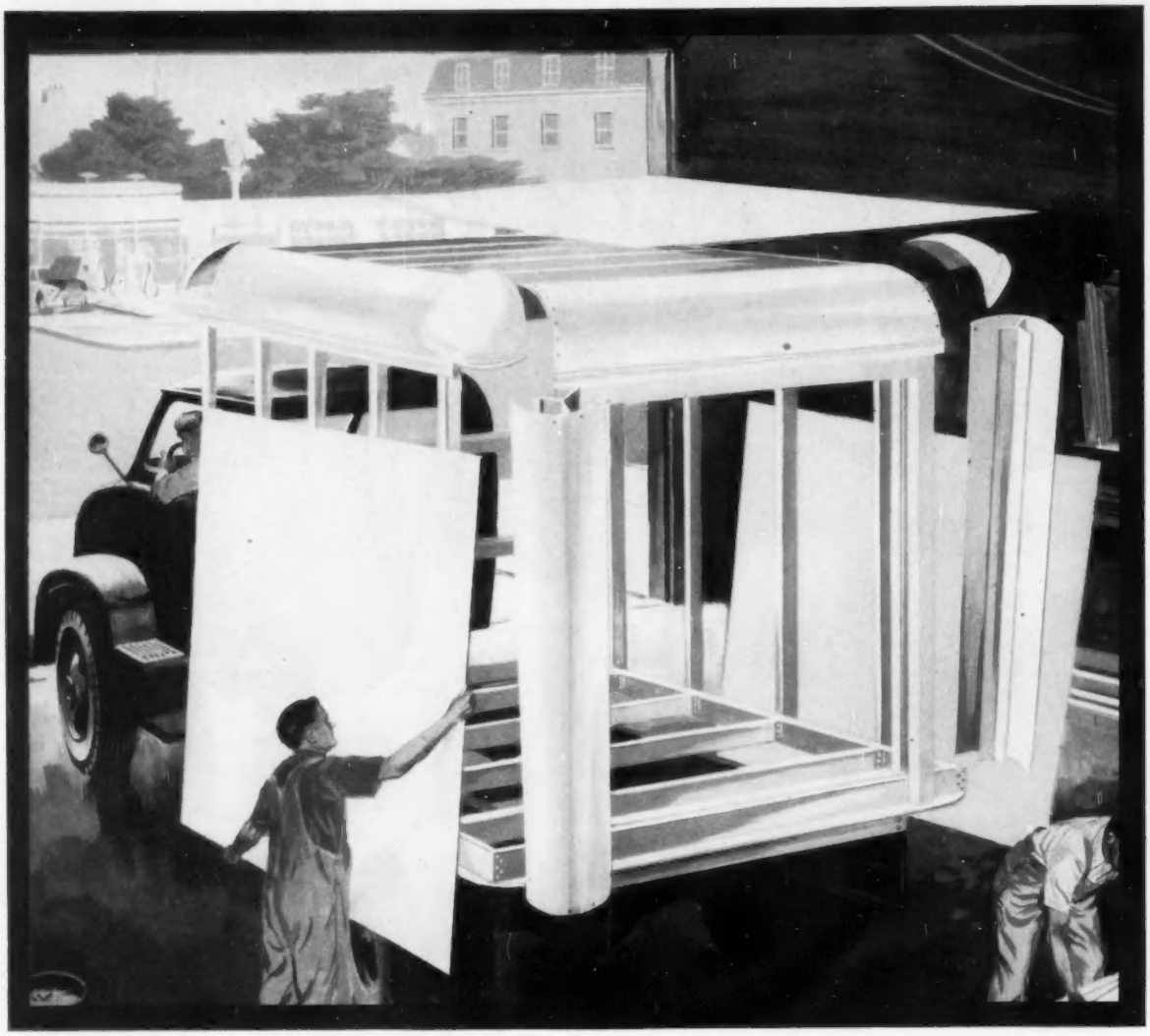
With Eaton 2-Speeds, trucks haul more, faster, and longer, at lower cost.

EATON
2-Speed Truck
AXLES

Axle Division
EATON MANUFACTURING COMPANY
CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves* Tappets* Hydraulic Valve Lifters* Valve Seat Inserts* Jet Engine Parts* Rotor Pumps* Motor Truck Axles* Permanent Mold Gray Iron Castings* Heater Defroster Units* Snap Rings Springtites* Spring Washers* Cold Drawn Steel* Stampings* Leaf and Coil Springs* Dynamatic Drives, Brakes, Dynamometers

Stronger, lower cost custom bodies built faster with Alcoa shapes



Alcoa® Aluminum Truck Body Shapes are in stock at your nearby Alcoa distributor. They are Alcoa Extrusions—precision engineered, putting the metal where it's needed. They eliminate costly build-ups and subassemblies, greatly reducing your construction costs and time.

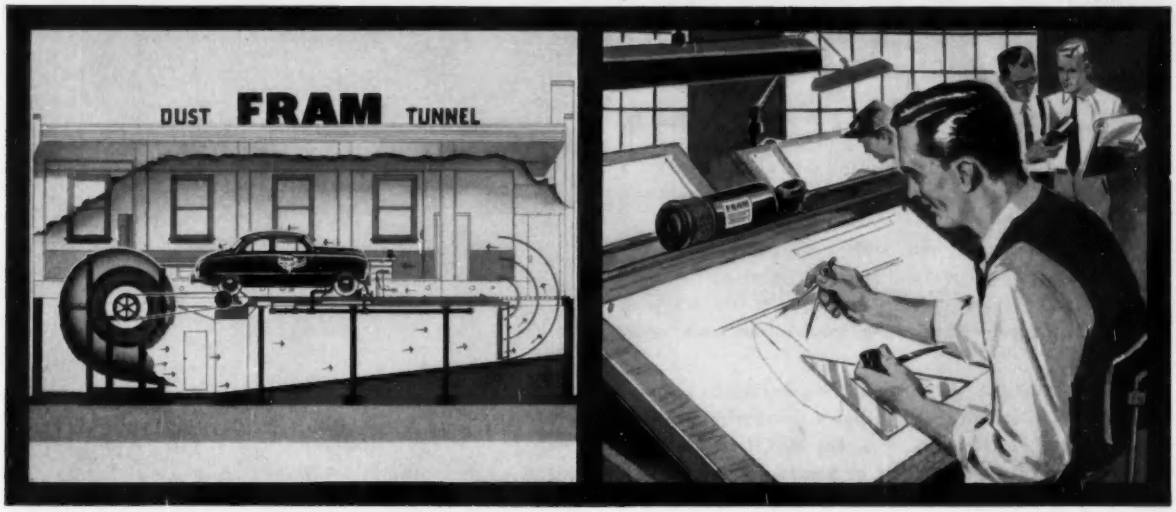
Among the many items stocked by Alcoa distributors are flooring, side sills, cross members, side posts, rub rails, top rails, roof bows and corner posts . . . Alcoa Angles, Tees and Zees for door framing, tail gates and other special applications . . . Alcoa Sheet and Plate for roofs and side sheets, doors and tail gates. And all are made to high Alcoa standards of alloy and workmanship.

These lightweight, cost-cutting shapes are readily available from your local Alcoa distributor . . . listed below. Write for the booklet, *Truck Bodies Fabricated From Alcoa Aluminum.* ALUMINUM COMPANY OF AMERICA, 1844-G Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

FRAM leads the industry



IN RESEARCH . . .

The FRAM Institute of Advanced Filter Research and Design at Dexter, Mich., is the leading research center of its kind in the world. Here, FRAM scientists and engineers study new filtration methods and materials . . . test new systems in the FRAM Dust Tunnel and in actual test-car operation. The facilities of this modern institute and the experience of its personnel are available to help you solve your filtration problems.

IN DESIGN . . .

No other filter manufacturer matches the variety and scope of FRAM products—proof of FRAM'S leadership in design. FRAM engineers also work closely with automotive manufacturers in designing special filter systems to exact automotive specifications and requirements. Whatever your filtration needs in . . . oil, fuel, air or water . . . consult FRAM.

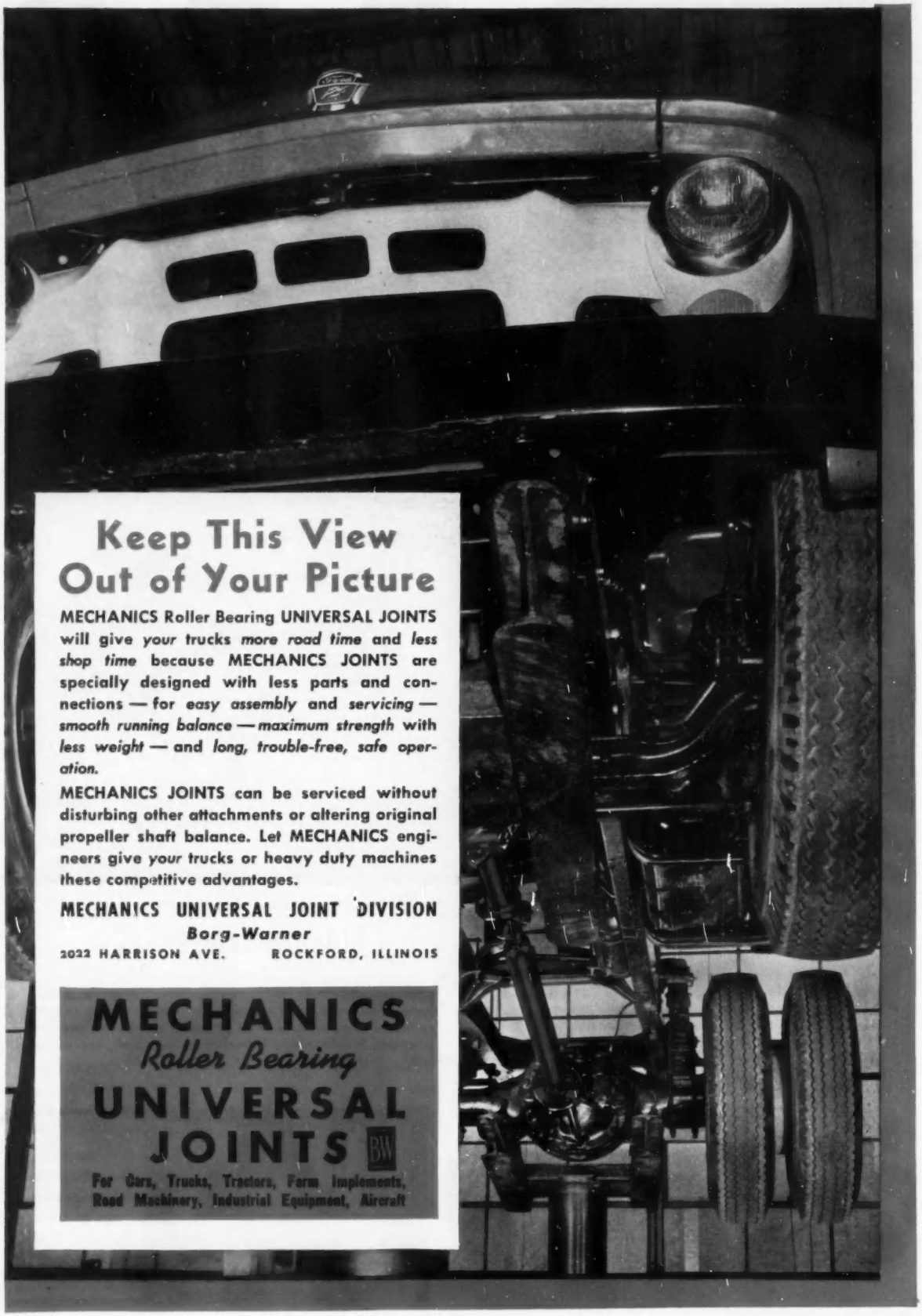
AND DEVELOPMENT

of better filtration for oil, fuel, air, water

FRAM
OIL • AIR • FUEL • WATER
FILTERS

Write:
FRAM CORPORATION,
Providence 16, R.I.

Fram Canada Ltd.,
Stratford, Ont.



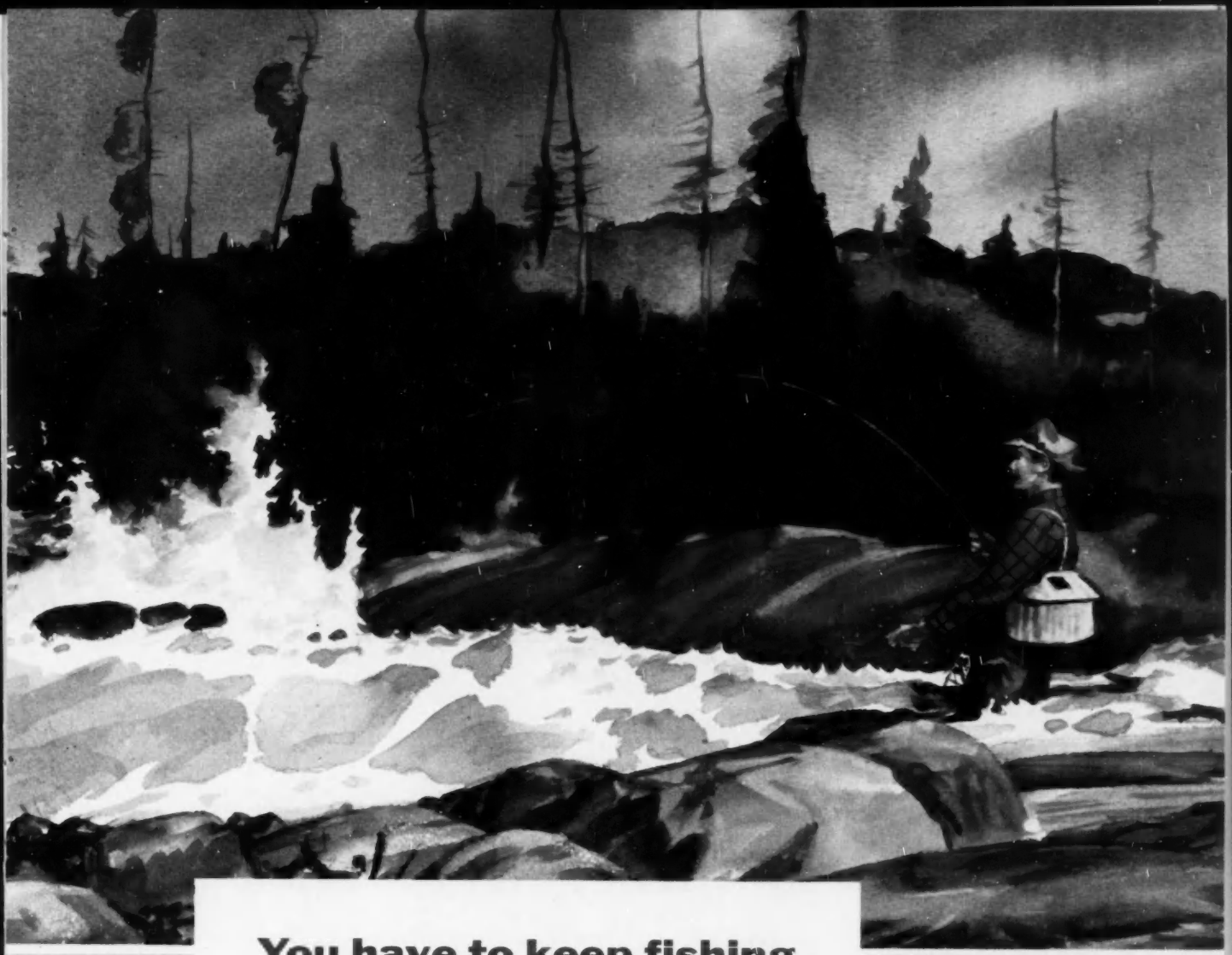
Keep This View Out of Your Picture

MECHANICS Roller Bearing UNIVERSAL JOINTS will give *your* trucks *more road time* and *less shop time* because MECHANICS JOINTS are specially designed with less parts and connections — for *easy assembly* and *servicing* — *smooth running balance* — *maximum strength* with *less weight* — and *long, trouble-free, safe operation.*

MECHANICS JOINTS can be serviced without disturbing other attachments or altering original propeller shaft balance. Let MECHANICS engineers give *your* trucks or heavy duty machines these competitive advantages.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner
2022 HARRISON AVE. ROCKFORD, ILLINOIS

MECHANICS
Roller Bearing
UNIVERSAL JOINTS BW
For Cars, Trucks, Tractors, Farm Implements, Road Machinery, Industrial Equipment, Aircraft



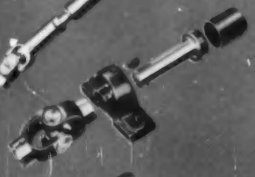
You have to keep fishing

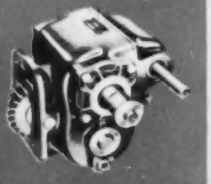
... if you want to keep your skill

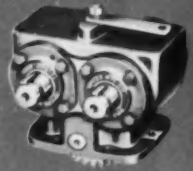
Spicer has been in the center of the stream
of automotive progress for 50 years.
Consistently . . . *year after year for a half-century* . . . Spicer has built
up a rich fund of power transmission knowledge and skill.
In peace and war . . . in every phase of civilian and military service . . .
Spicer automotive equipment has convincingly demonstrated why
it has earned the reputation of

"The Standard of the Industry"

ENGINEERING
DANA
MANUFACTURING







SPICER POWER TAKE-OFFS

...built with the skill gained from 50 continuous years of experience in power transmission design

Spicer Power Take-Offs and Spicer Power Take-Off Joints embody all the advantages of Spicer engineering, Spicer precision manufacturing, and Spicer dependable performance. These units are available in a wide range of models to meet every service requirement. They are more widely used than any other similar type of equipment.

Spicer engineers offer the benefit of their vast experience to assist you in the adapting of Spicer Power Take-Off units to the particular needs of your product. Spicer Power Take-Offs are designed to meet all operating conditions of continuous or intermittent service. They include Medium and Heavy Duty Single, Dual and Reversible Speed Models for all service vehicles. For many years Spicer units have been

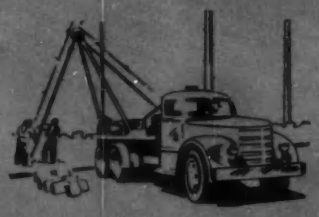
"Preferred by the Trucking Industry!"

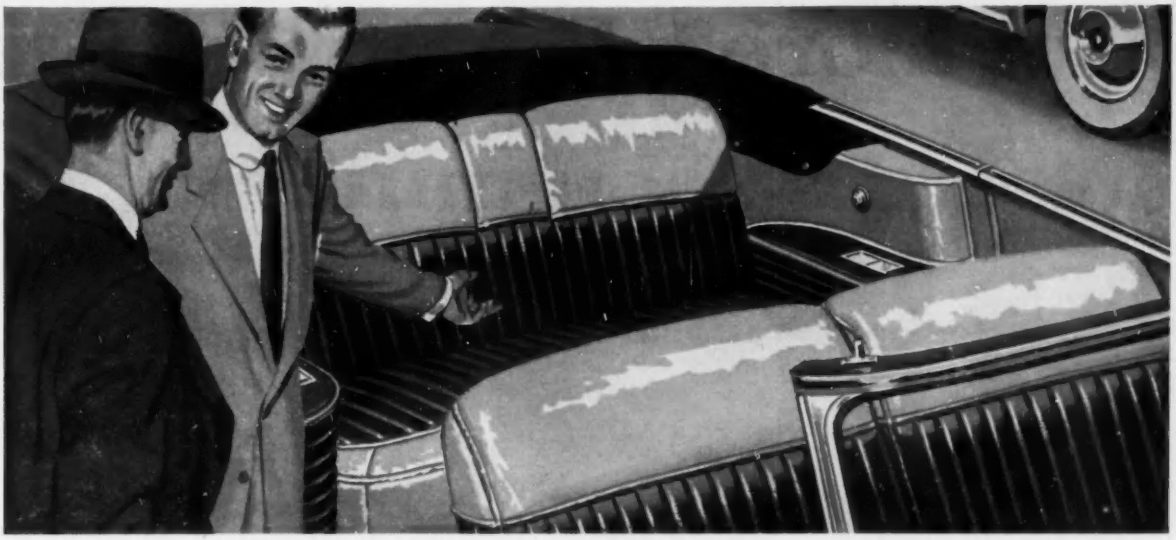
SPICER MANUFACTURING DIVISION
of Dana Corporation
Toledo 1, Ohio

50 YEARS OF Spicer SERVICE

ENGINEERING
DANA
MANUFACTURING

TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • BROWN-LIPE *and* AUBURN CLUTCHES • FORGINGS • AXLES • STAMPINGS • SPICER BROWN-LIPE GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • AIRCRAFT GEARS • WELDED TUBING





There's added Profit and added Value in every car you sell with . .

genuine Leather

● Almost *anyone* who can afford a car can afford the advantages of genuine upholstery leather. Statistics show that almost ⅔ of all cars sold leave the showroom slip-covered. Yet leather costs little more than good covers—and gives *you* extra profit.

Genuine upholstery leather is easy to sell because no other material adds so much value to a car for so little. Leather takes rugged wear and tear in stride . . . comes clean at the wipe of a damp cloth . . . keeps its beauty for years. Leather stands up to sunlight without fading—remains comfortable in all weather—is easy to "slide" on at all times. Leather's colors and finishes are almost limitless and almost indestructible . . . with a rich patina that becomes handsomer with age. Most important, genuine upholstery leather is true trade-in insurance for car buyers because it steps-up the resale value of any car.

WRITE FOR FREE BOOKLET

This new free booklet, "All about Genuine Upholstery Leather," contains some sales-provoking facts about leather and conclusive proof that genuine upholstery leather is the best buy for you and your customers. Write for it today. There's no obligation.

Only Genuine Upholstery Leather Wears as Well as It Looks

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* THE ASHTABULA HIDE & LEATHER CO., Ashtabula, Ohio
* BLANCHARD BRO. & LANE, Newark, N. J.
* EAGLE-OTTAWA LEATHER CO., Grand Haven, Mich.
* GARDEN STATE TANNING, INC., Pine Grove, Pa.
GOOD BROS. LEATHER CO., Newark, N. J.
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THE UPHOLSTERY LEATHER GROUP, INC.
141 East 44th Street, New York 17, N.Y.

Please send your new booklet "All About Genuine Upholstery Leather." No obligation of course

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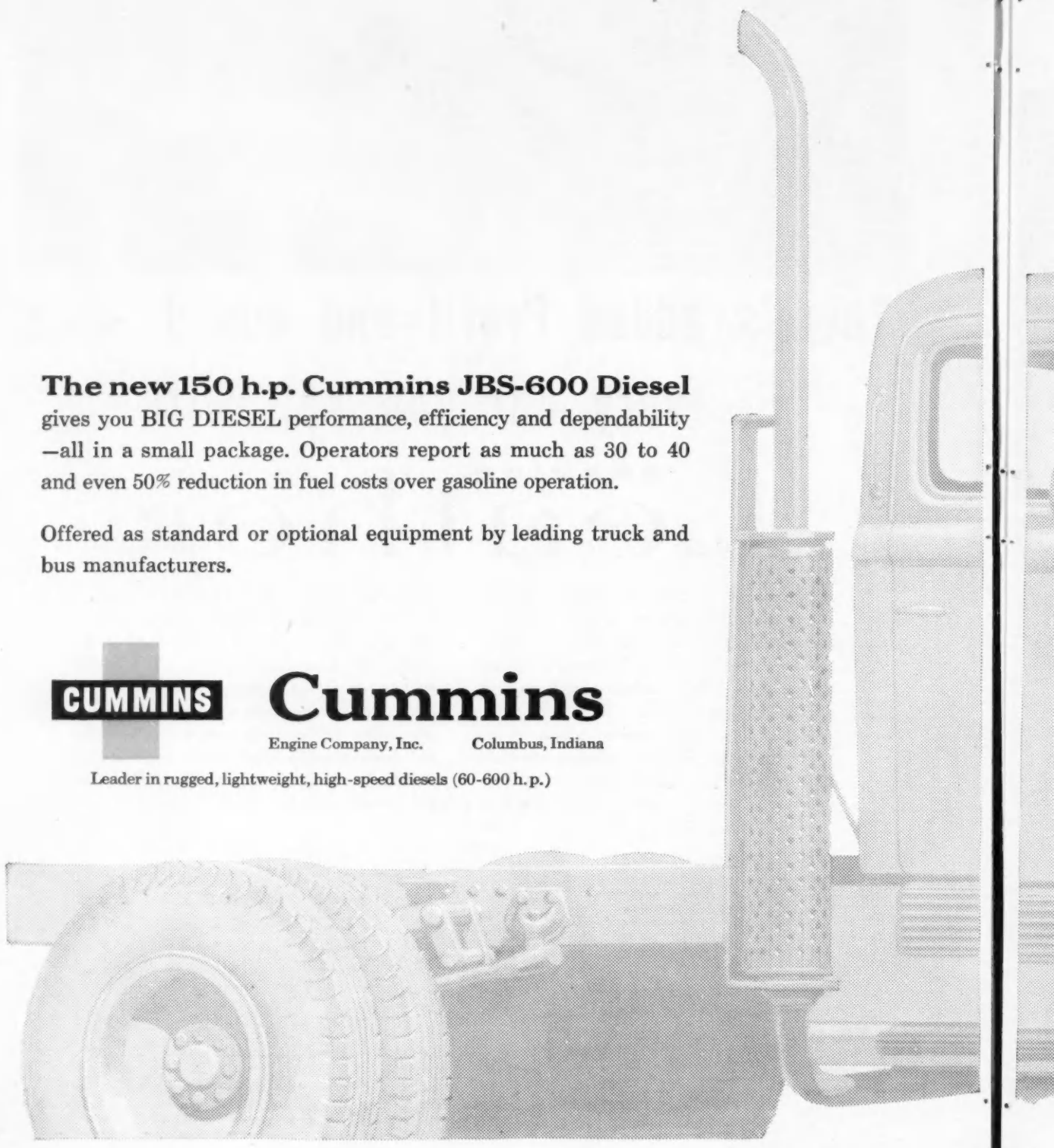
Get more mileage per fuel



The new 150 h.p. Cummins JBS-600 Diesel gives you BIG DIESEL performance, efficiency and dependability —all in a small package. Operators report as much as 30 to 40 and even 50% reduction in fuel costs over gasoline operation.

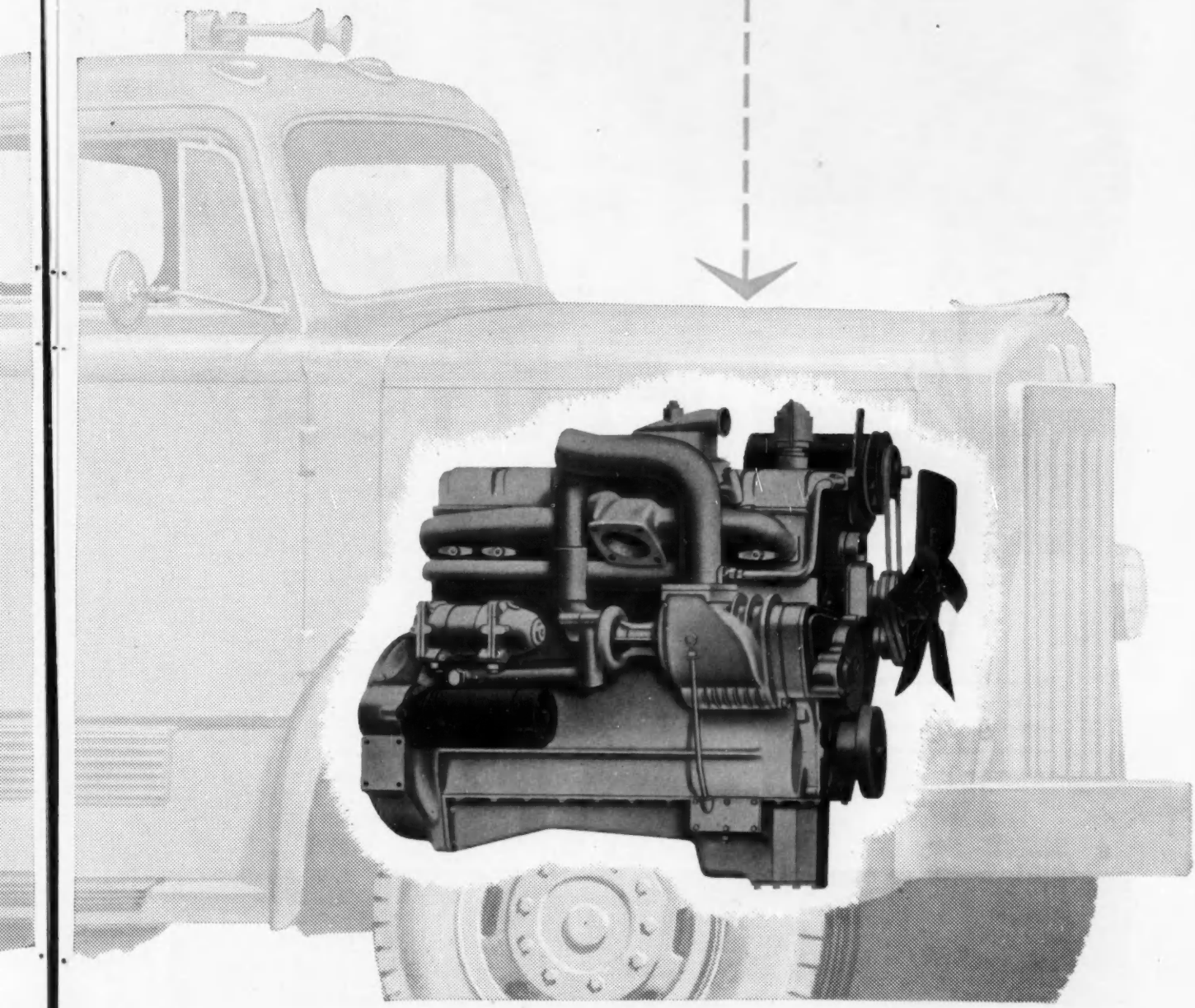
Offered as standard or optional equipment by leading truck and bus manufacturers.

CUMMINS **Cummins**

Engine Company, Inc. Columbus, Indiana

Leader in rugged, lightweight, high-speed diesels (60-600 h. p.)

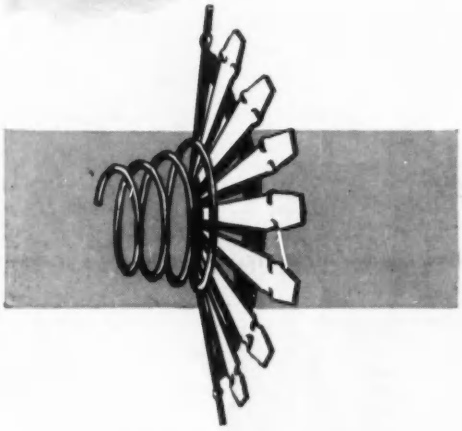
dollar with your medium-heavy trucks



The SOFT Acting Clutch with the SURE GRIP!

...Just like a Hand of Steel in a Velvet Glove

LIPE MULTI-LEVER CLUTCH



The hand of steel in the Lipe Clutch has 20 fingers that equalize the pressure of a single spring—assuring softer engagement and a positive grip.

Lipe's soft engagement, positive grip Multi-Lever Clutch never needs babying. It engages smoothly —without grab, shock or jerk. All parts of the pressure plate touch at the *same instant* with the *same* pressure. No cocking—no point of high slippage and spot burning.

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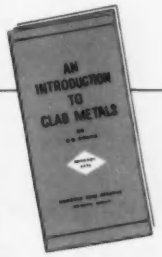

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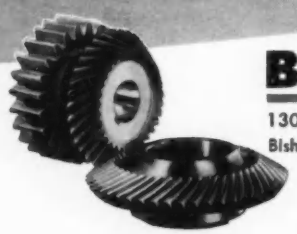

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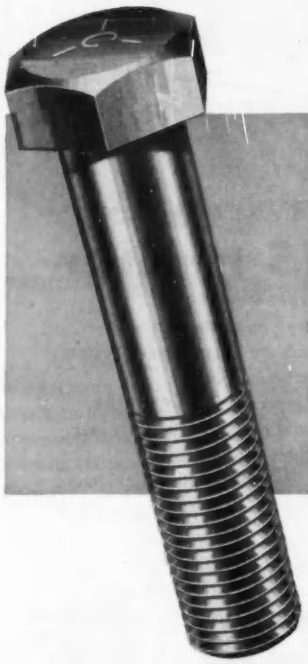

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Our warranty does not apply to any of our products which have been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by us.
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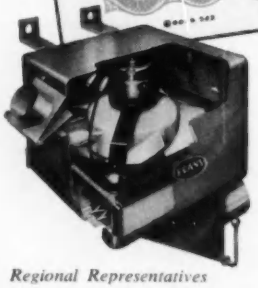

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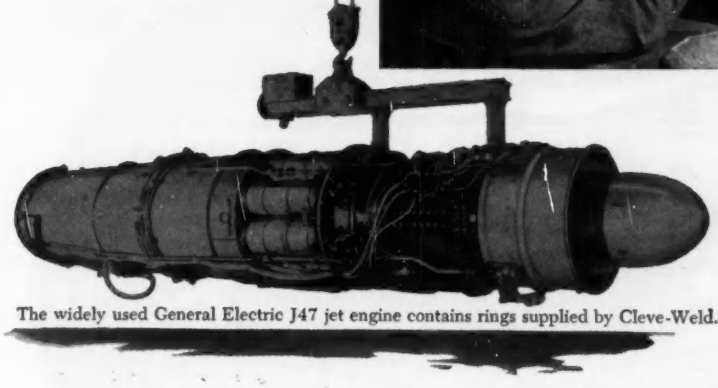
The largest quench press of its kind prevents distortion during heat-treating and assures uniform structure of Cleve-Weld jet rings.



The widely used General Electric J47 jet engine contains rings supplied by Cleve-Weld.

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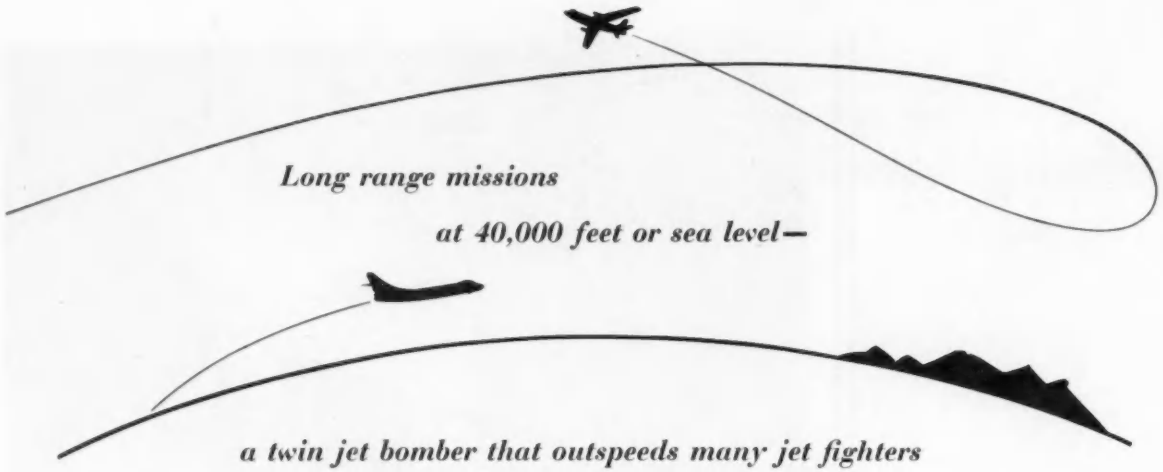
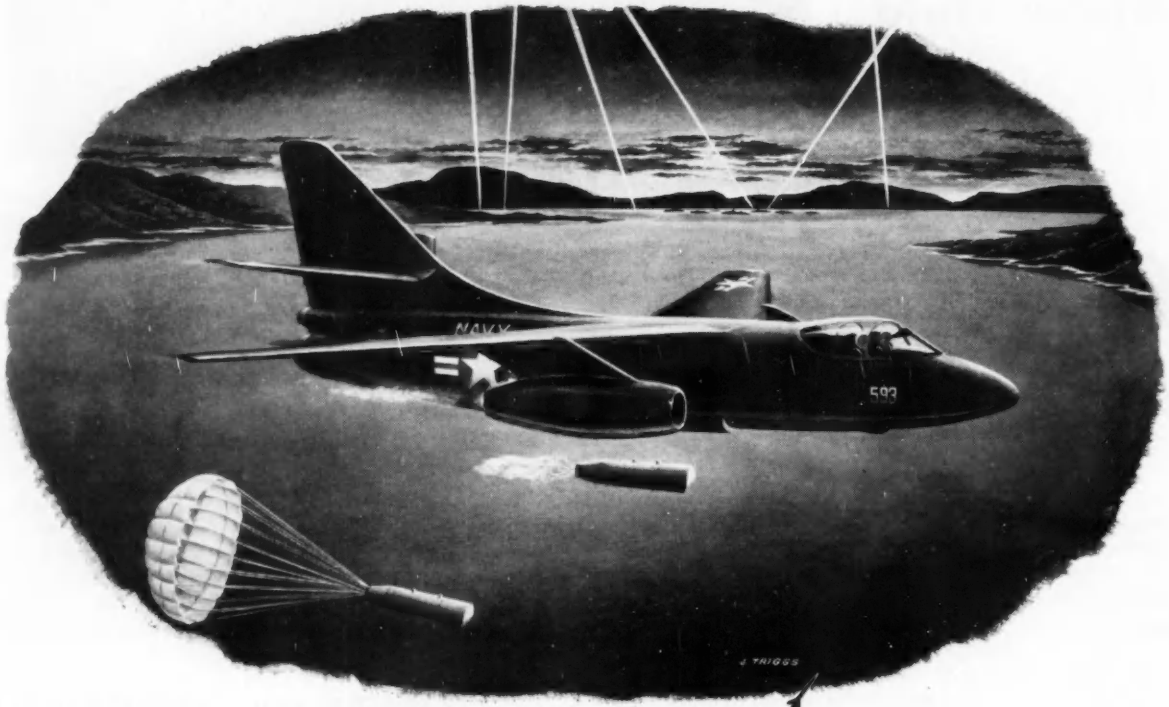


—the U. S. Navy's Douglas A3D

Compact in design, outstanding for its work-weight ratio, the carrier-based twin jet A3D typifies a Douglas-led trend toward less complex combat aircraft.

Simplification, which gives A3D greater speed, range, and payload than any comparable bomber, also results in great versatility. The Douglas A3D can fly high-altitude attack missions or serve as a mine layer. Largest of all carrier-based aircraft, it can handle—in its internal bomb bay—the bulkiest bombs, torpedoes, or other naval munitions designated for carrier action.

Design of A3D is another example of Douglas leadership in aviation. Developing planes that can fly *faster and farther with a bigger payload* is a basic Douglas concept.



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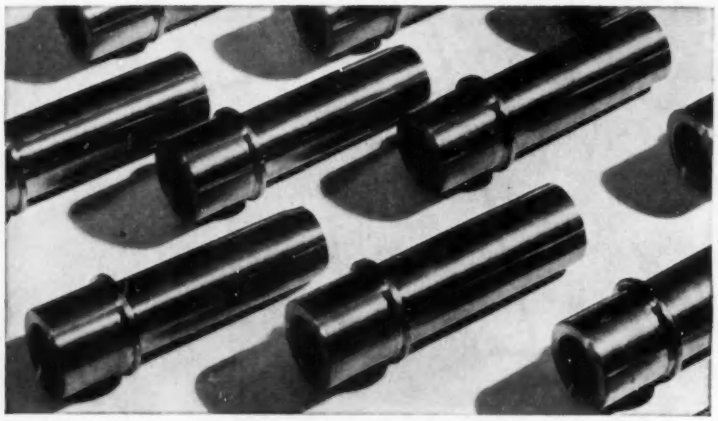

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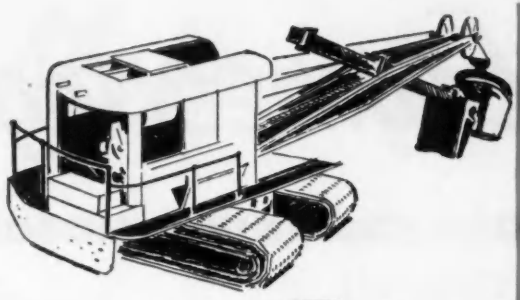

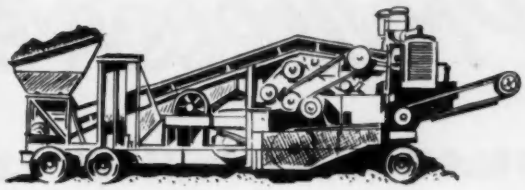

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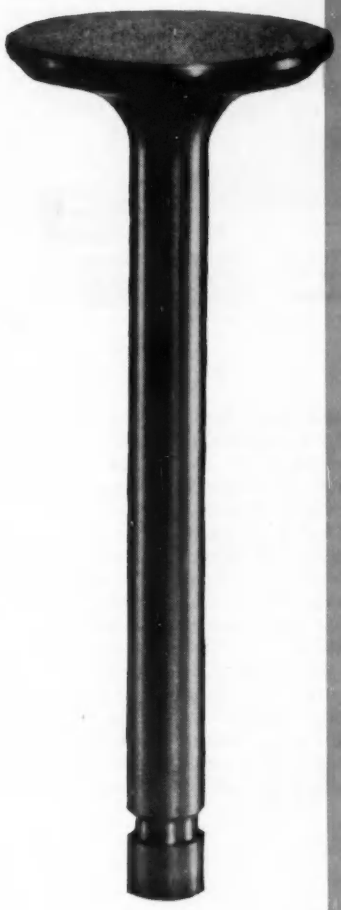

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Take a tip from Waukesha and other famous engine builders . . . count on Thompson for engineering leadership in valves and valve rotation.

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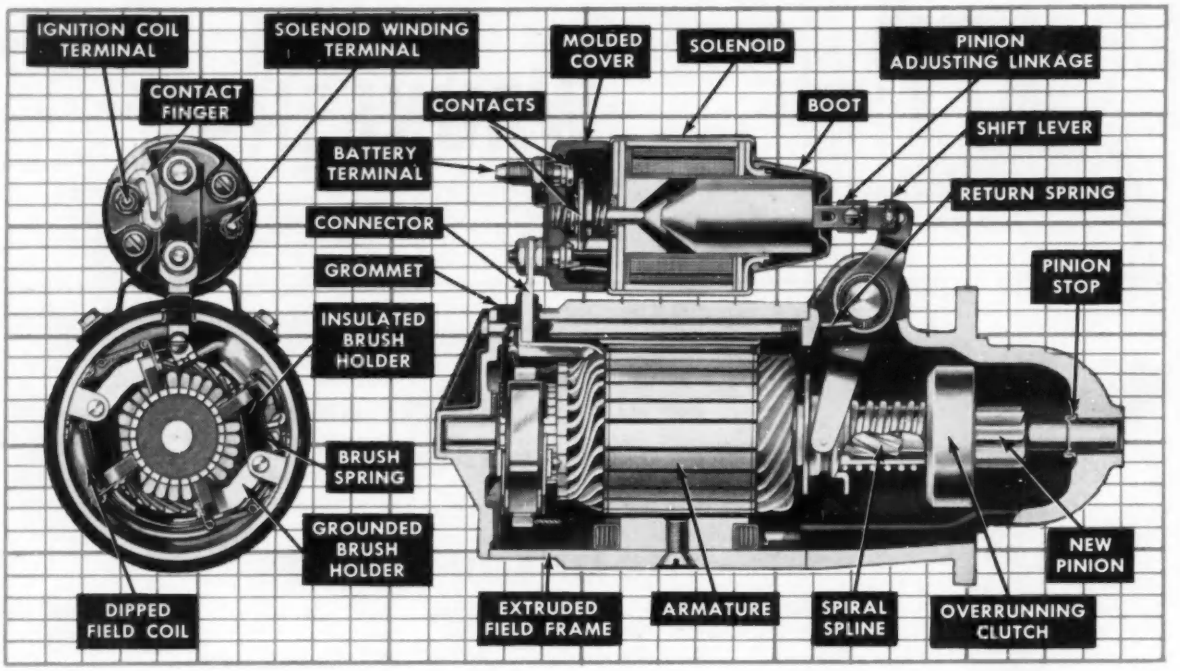
Progressive Engineering

DELCO-REMY'S NEW 12-VOLT CRANKING MOTOR



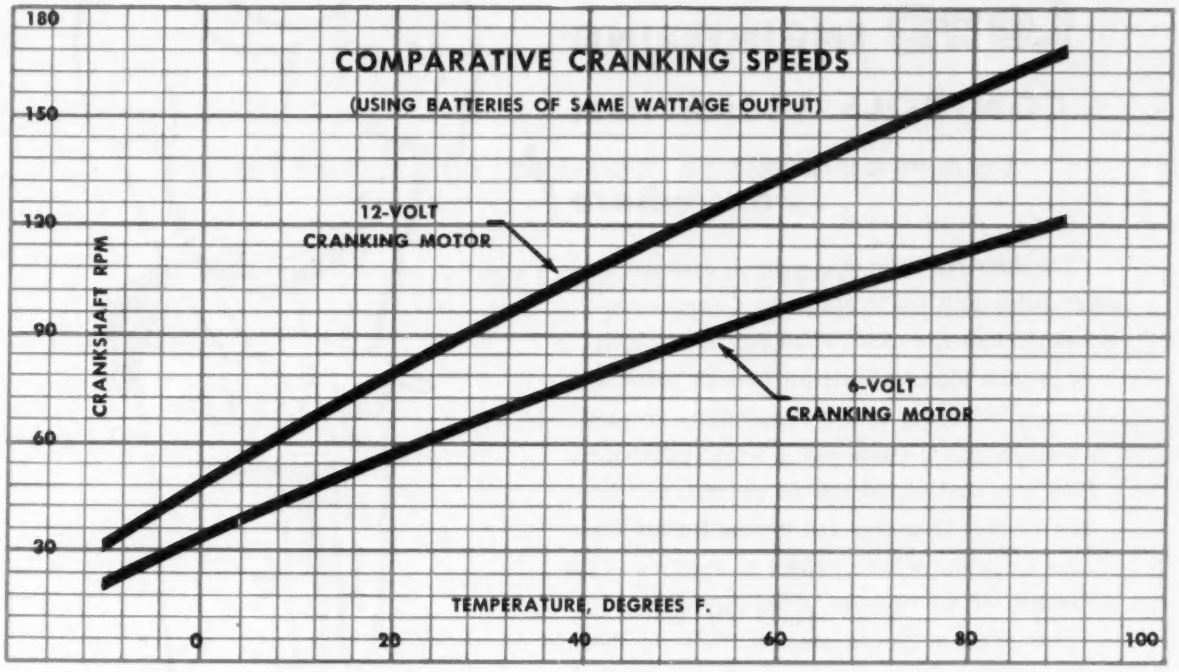
Three important advantages of the Delco-Remy 12-volt electrical system for passenger cars are better ignition performance, greater generator efficiency, and improved cranking motor performance. To insure better cranking, Progressive Engineering at Delco-Remy has developed an extruded-frame cranking motor incorporating many advanced features designed to take full advantage of the possibilities of the 12-volt system.

A typical new 12-volt motor weighs less than a comparable 6-volt unit, yet spins the engine faster—even when powered by a battery of the same wattage. Actual tests show as much as 50% increase in cranking speed at 10 below zero F., as much as 40% increase at 90 degrees above. Higher cranking speeds, of course, contribute importantly to quicker starting. In hot weather, when vapor lock and fuel percolation may occur, faster cranking more quickly pumps out the vapor. In cold weather, faster cranking gives better distribution of the fuel mixture to the cylinders.

This cranking motor owes its remarkable performance to a higher torque derived from more armature conductors and stronger fields and to an improved cranking ratio made possible by a new, smaller pinion with specially developed tooth shape. Important mechanical features include: mating spiral splines of shaft and clutch prevent transmission of full cranking power until pinion is

Makes the Difference

SPINS ENGINE FASTER FOR QUICKER STARTING IN ANY WEATHER



fully engaged . . . a new pinion stop assembly keyed to the shaft absorbs damaging end thrust . . . an improved shift lever linkage makes adjustment easier . . . a new type grommeted bus bar provides a simpler connection between motor and solenoid . . . a new molded insulating cover on the solenoid reduces the hazard of short circuits and grounds . . . the extruded frame is finish-formed to exact internal dimensions . . . new frame-mounted tandem brush holders permit simplified internal wiring . . . field coils and leads are dip-coated with elastic insulation for maximum protection with minimum bulk . . . armature windings are bonded in place with special filler.

It is through such Progressive Engineering that Delco-Remy succeeds in being always abreast—usually ahead—of developments in the automotive industry. Whenever the need arises for further advances in electrical equipment, count on Delco-Remy to be ready.

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DIVISION, GENERAL MOTORS CORPORATION, ANDERSON, INDIANA

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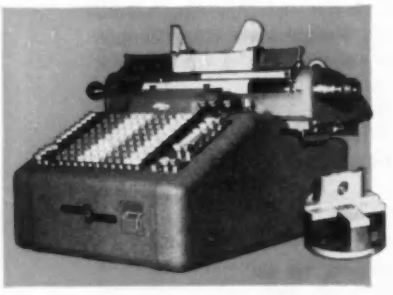

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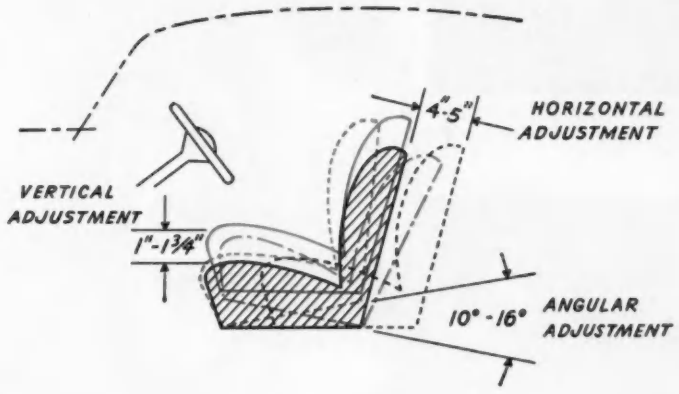
amp was the "first" to offer this major improvement in motoring pleasure



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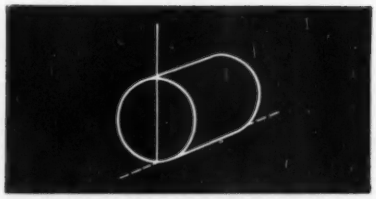
increases bearing efficiency



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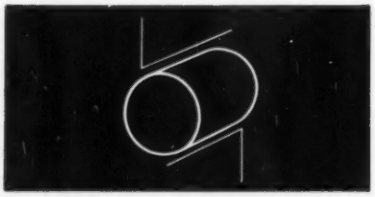

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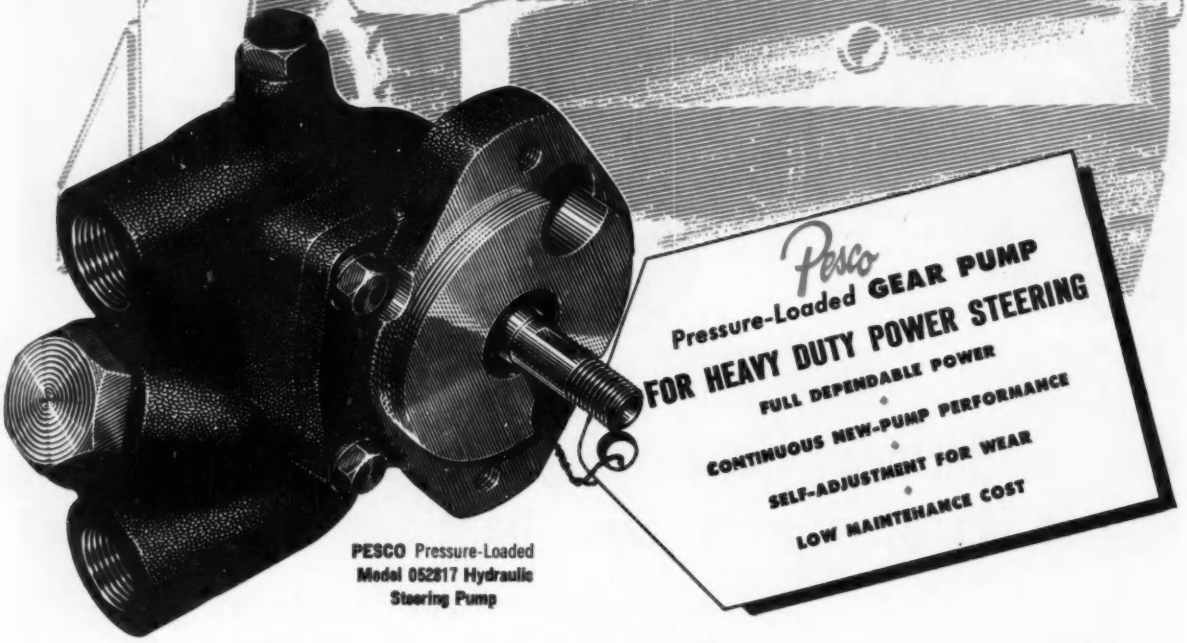

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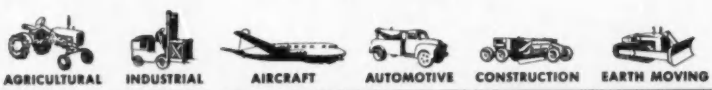

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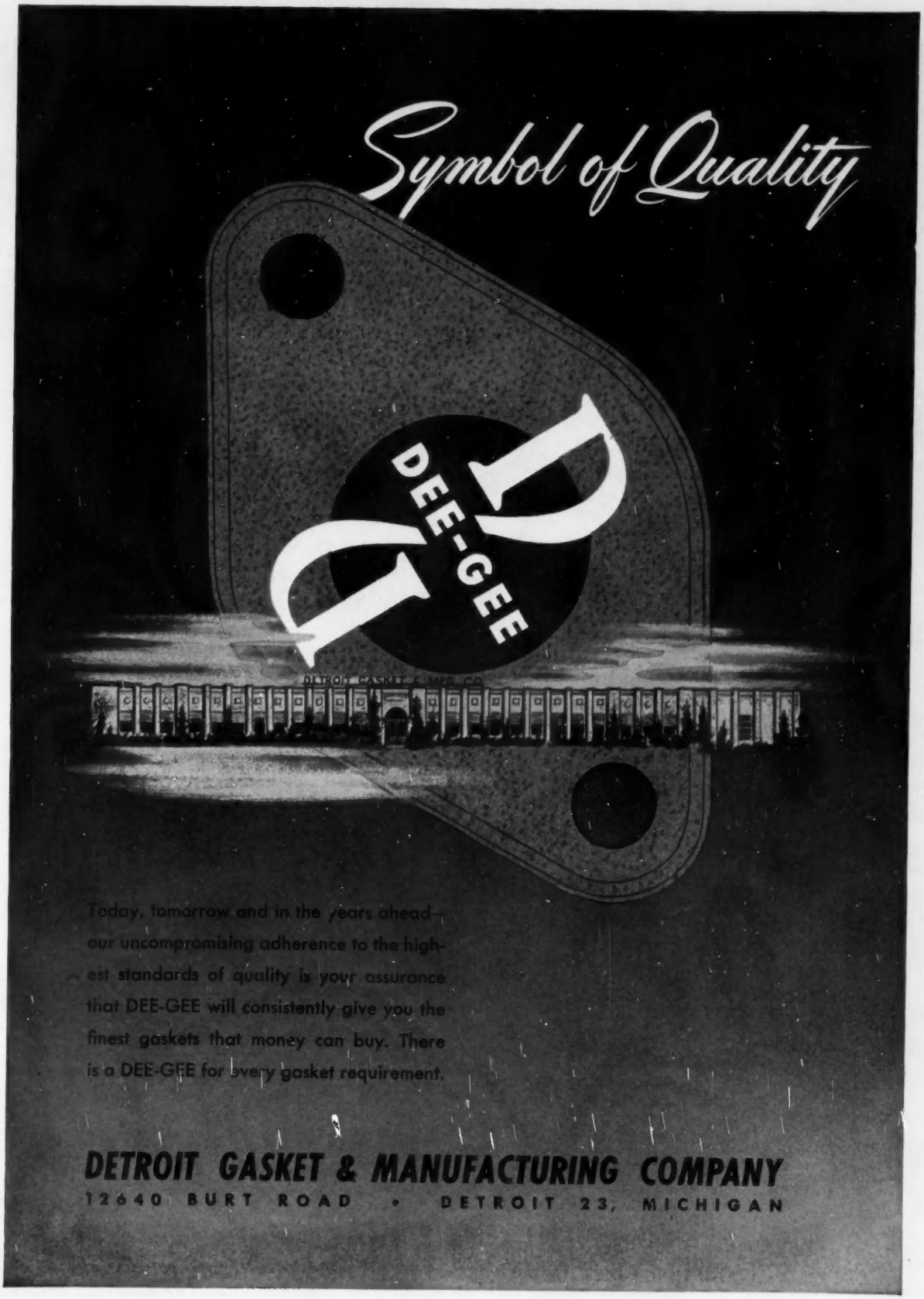
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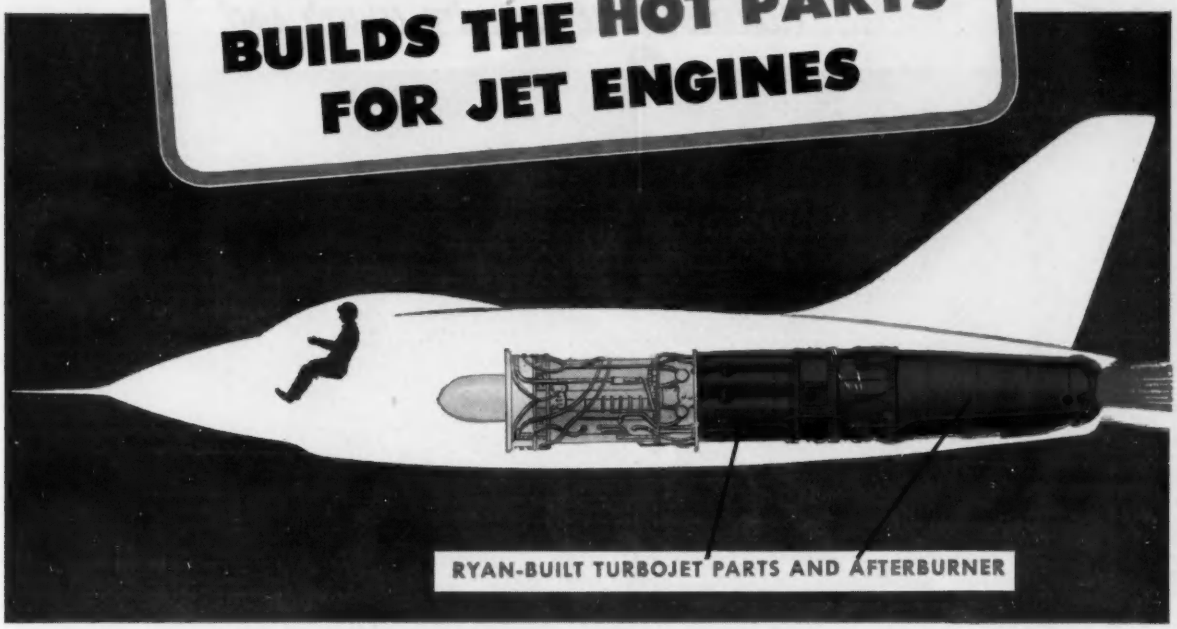
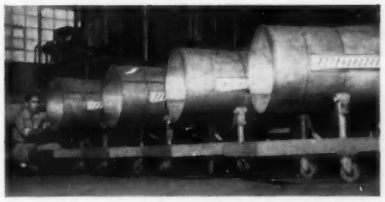


The startling performance of America's great new fighters and bombers depends largely upon the knowledge and skill of the manufacturer of their jet engine components. These rugged "hot parts" must be built to jewel-like precision and exhibit amazing strength under extremely high temperatures.



Ryan Afterburners for Westinghouse J-46

Ryan is a pioneer in this field, developing the first American jet engine afterburner in connection with the Navy's first jet plane, also built by Ryan. Today, Ryan leads in the fabrication of sheet metal turbojet components and afterburners because of a unique combination of advantages: long experience in high temperature metallurgy – extensive know-how in forming, welding and machining heat-resistant alloys – the industry's most modern array of high precision machines. Few plants anywhere have the necessary equipment, methods and know-how for this specialized work.

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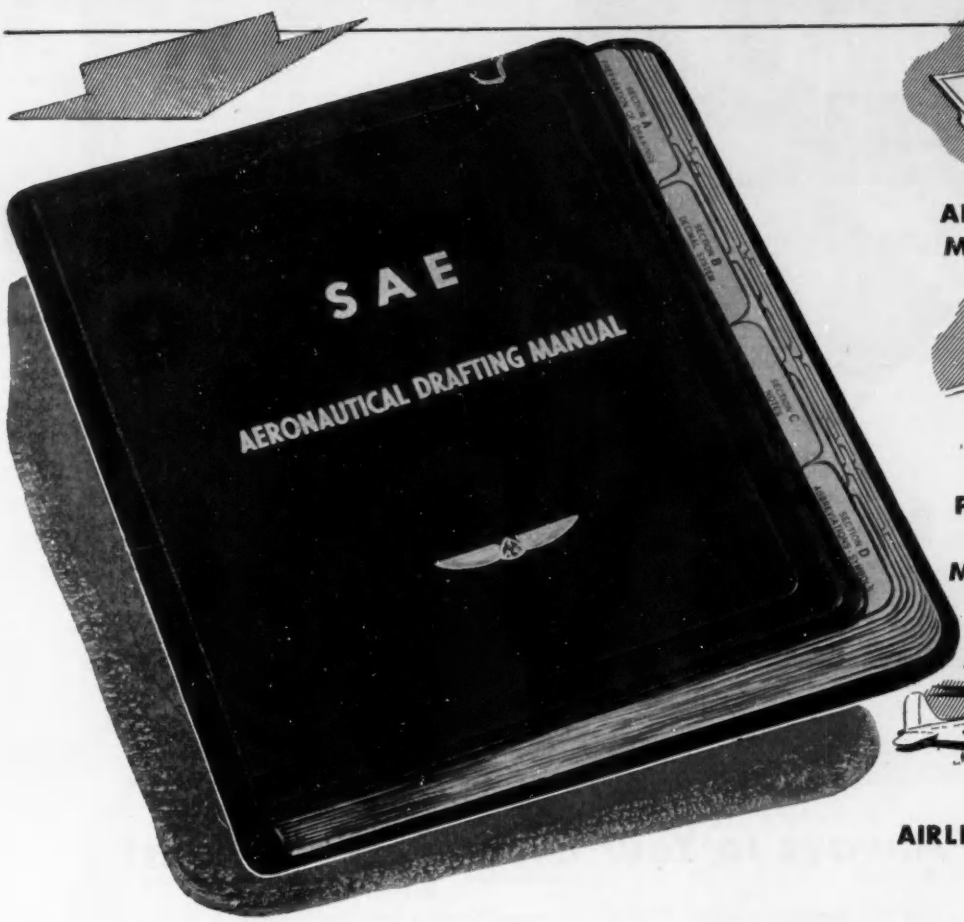

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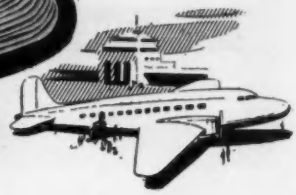

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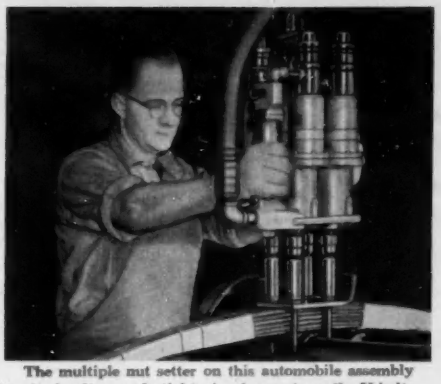

The multiple nut setter on this automobile assembly line is simultaneously tightening four nuts on the U-bolts which attach the rear axle to the springs. Continued inspection shows that production is held well within the 60-65 ft-lb of torque specified on this operation.

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Multiple Nut Setter

saves time — holds torque limits !

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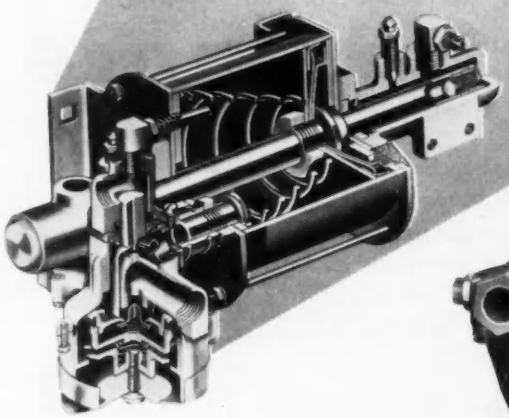
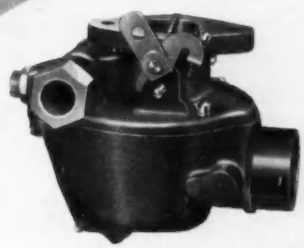
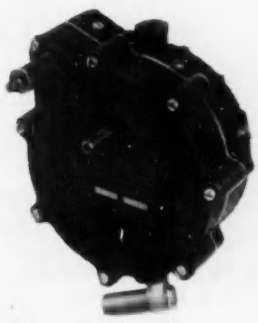


Power Brakes for Passenger Cars and Trucks





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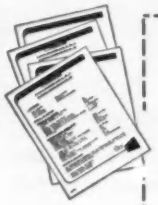

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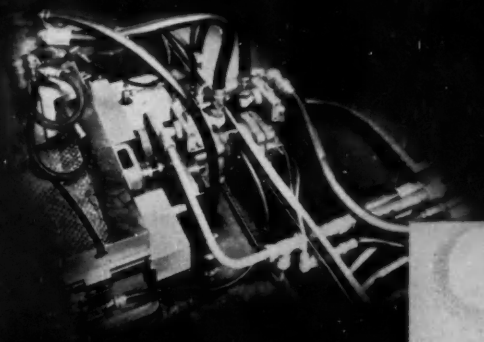

Weatherhead hose and coupling assemblies link this Van Norman grinder to its Vickers power unit. Replacements are readily made from stocks of bulk hose and matching couplings.

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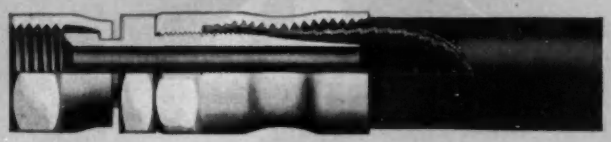

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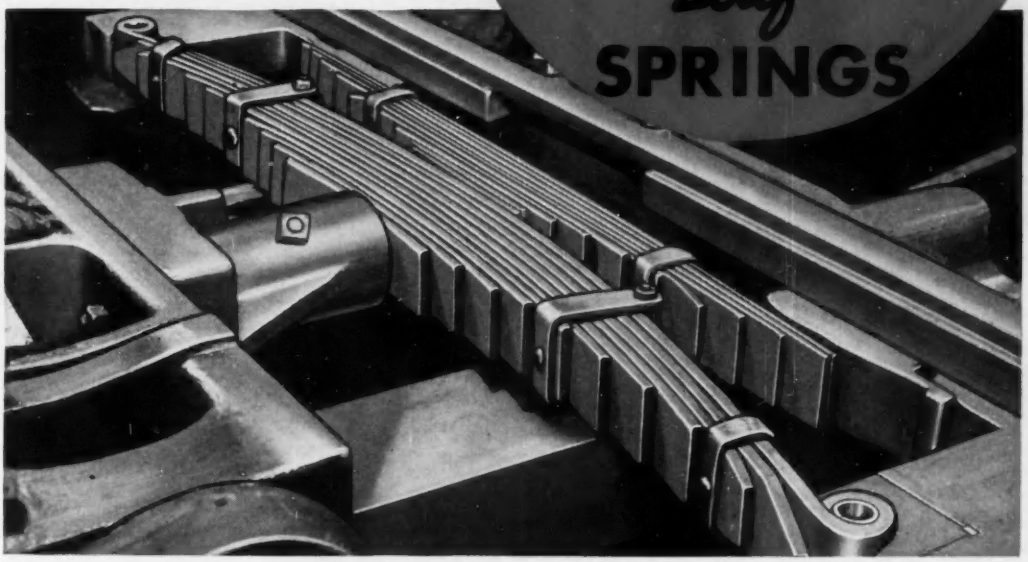

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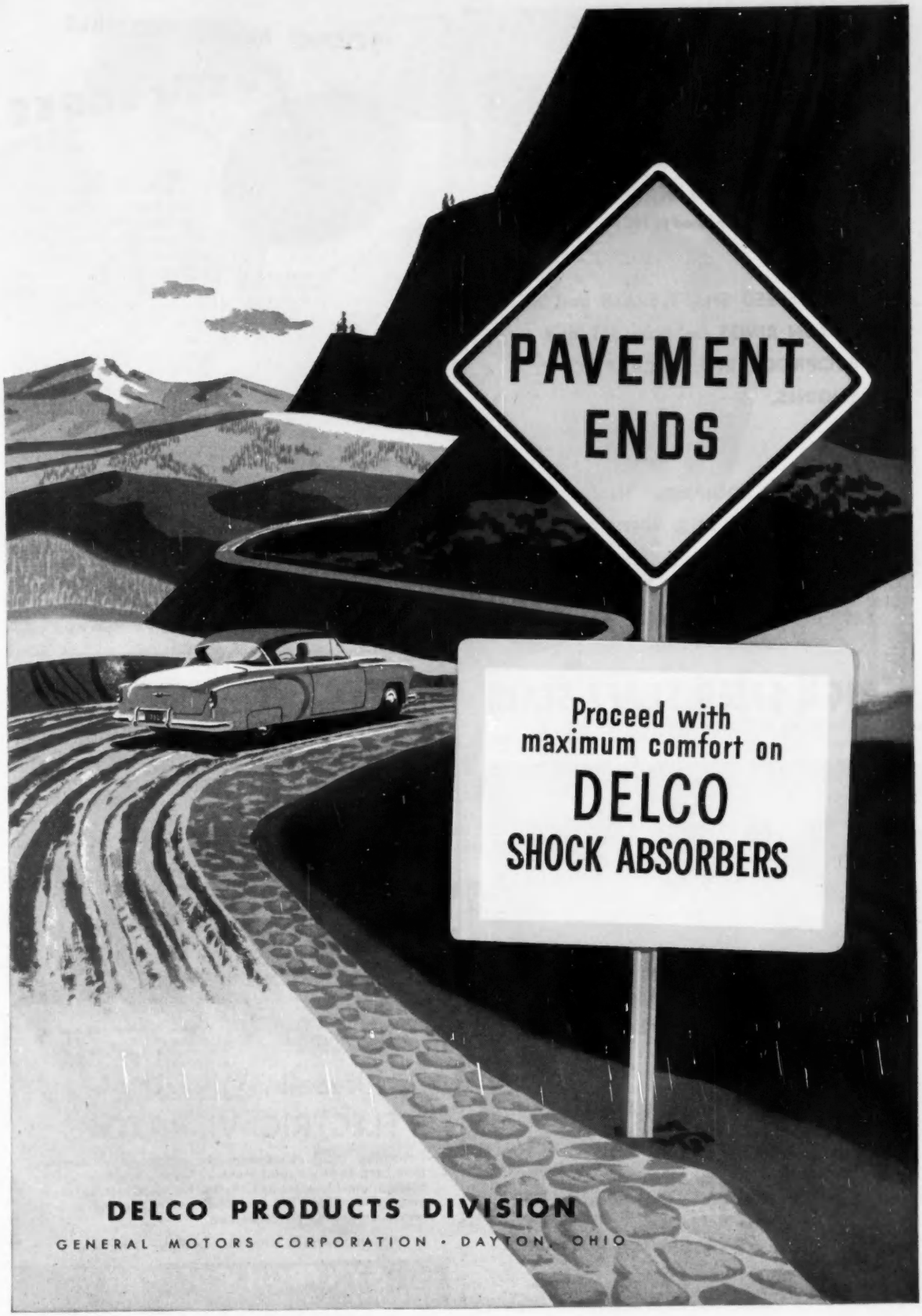
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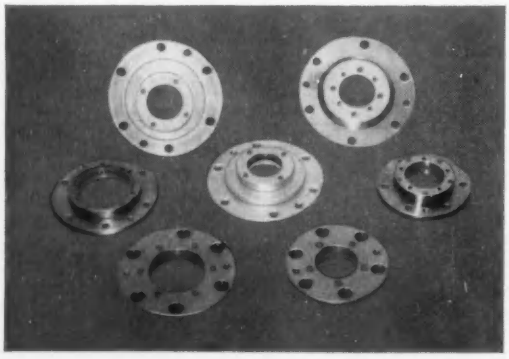

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Vacuum cleaner air filter and a sweat band, both with sealed edges.

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Vacuum cleaner filters
Powdered soap containers
Face powder pads
Insulation
Clothing lining
Fluid filters
(The field has barely been scratched!)

Thermoplastic man-made fibres can be felted and fabricated into special parts for assembly or use without further processing. The felt within the edges can have any desired porosity, within wide limits. Thus these fused-edge felts have great versatility, and are capable of rendering many different services. It will pay you to look into what they can do for you. Write for information on your company letterhead.

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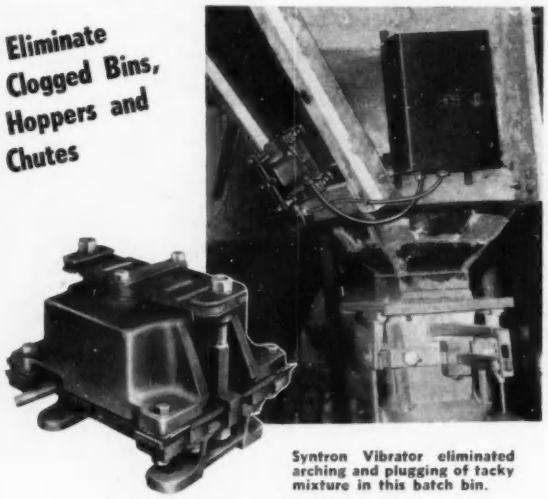
Eliminate Clogged Bins, Hoppers and Chutes



Syntron Vibrator eliminated arching and plugging of tacky mixture in this batch bin.

Install SYNTRON ELECTRIC VIBRATORS

Delivering 3600 electromagnetic vibrations per minute, they keep even the most stubborn materials moving freely through bins, hoppers and chutes. No more arching, plugging or clogging. The low cost, easily installed way to insure uninterrupted production.

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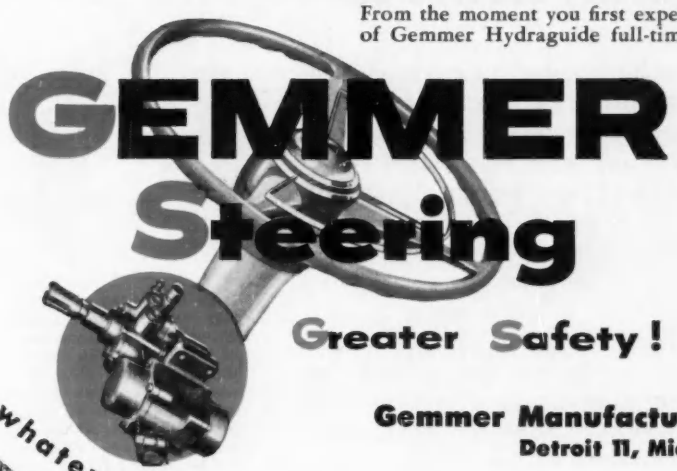
From the moment you first experience the sure, effortless driving feel of Gemmer Hydraguide full-time power steering, you'll know what driving for fun really means. Gemmer Hydraguide removes the you-power from steering . . . 80% of the actual work is done by the Gemmer unit. You sit behind the wheel relaxed, safe and confident. In case of blow-out, soft shoulder or front wheel obstruction, Gemmer Hydraguide is there . . . giving you complete control. Get Gemmer Hydraguide full-time Hydraulic power steering for your car, truck, boat, farm or material handling equipment. Driving is fun with Gemmer steering. It's a pleasure to ride with Hydraguide.



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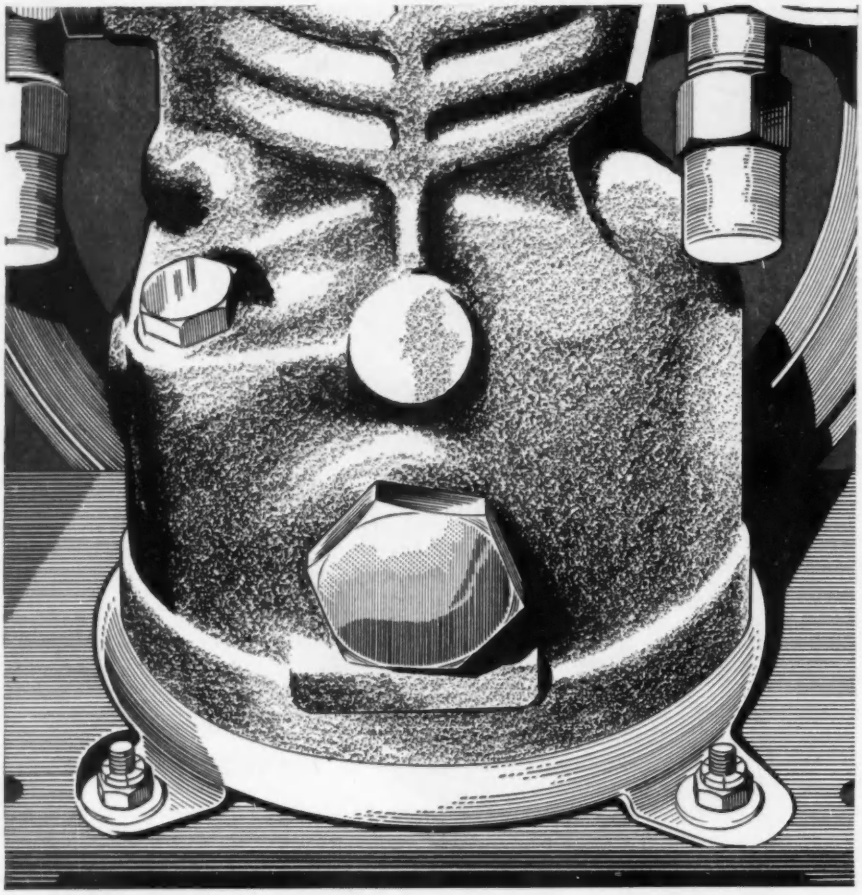
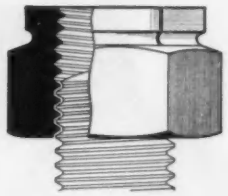


Many manufacturers use FLEXLOCS to fasten motors, compressors and other vibrating equipment to mounting plates. FLEXLOCS won't work loose . . . they eliminate costly service calls.

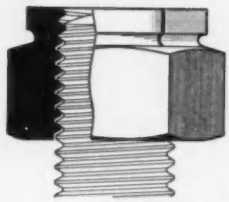
FLEXLOC locknuts reduce costly service calls

FLEXLOC locknuts do this because they stay put anywhere on a bolt as soon as their locking threads are fully engaged. Even the most severe vibration will not work them loose. FLEXLOCS offer many other advantages, too. *They are one piece.* They eliminate complicated, time-consuming methods of locking studs and bolts. They provide simpler, faster application and safer, more dependable locking than plain nuts and lockwashers, castellated nuts and cotter pins, nuts and jam nuts. They save buying, stocking and handling of extra parts. *They are all metal.* They have higher tensile strength than most other lock nuts. They permit you to stock only one nut for all temperatures to 550°F. *They are reusable.* They can be applied again and again without losing locking efficiency—a plus value in maintenance.

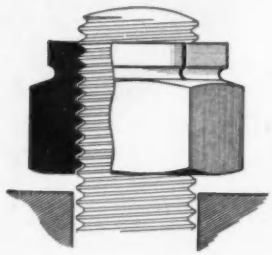
For information about FLEXLOCS and samples for test purposes, see your FLEXLOC distributor or write STANDARD PRESSED STEEL CO., Jenkintown 55, Pa.



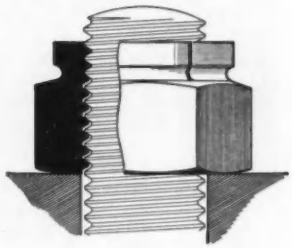
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC® LOCKNUT DIVISION

SPS
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THE ELECTRIC AUTO-LITE COMPANY • TOLEDO 1, OHIO

MB cycling system runs vibration tests automatically

Versatile electronic "brain" for MB Vibration Exciters saves manpower and manhours—performs a variety of cycled shake-tests unattended!

A vibration test that involves a continuous cycle of changes from 10 to 500 cps along with constant displacement or constant acceleration can now be done with great simplicity, accuracy and minimum supervision. Simply set up the specimen on an MB Shaker—set the controls for the desired actions—and let the cycling system take over.

This electronic unit varies shaker frequency at any sweep speed, and between any two preset frequency limits. It controls the exciter's amplitude or acceleration within ±10% for a dead mass or resonant type of loading and for cycled tests to satisfy MIL-E-5272 and other specifications.

For maximum flexibility of operation, this cycling system also provides for automatic transfer of constant amplitude to constant "g" at any preselected frequency setting.

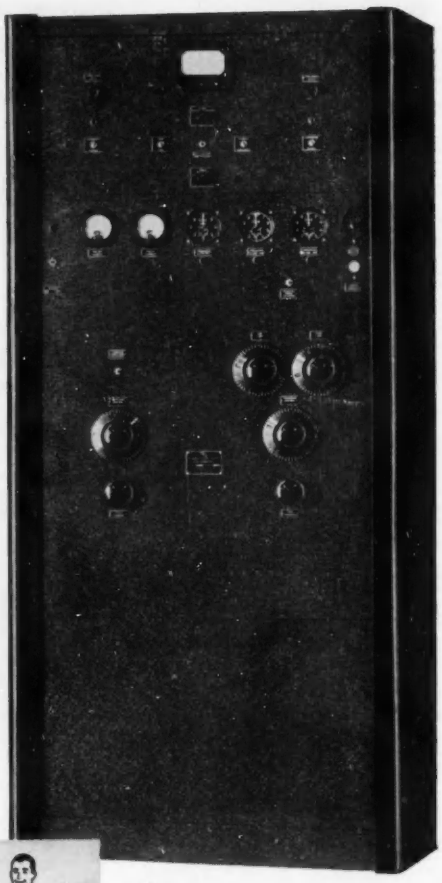
The system can be operated manually when desired. It's also protected against control failure or conditions of extreme load resonances through use of an automatic structural strain control.

SHAKE TESTING PAYS

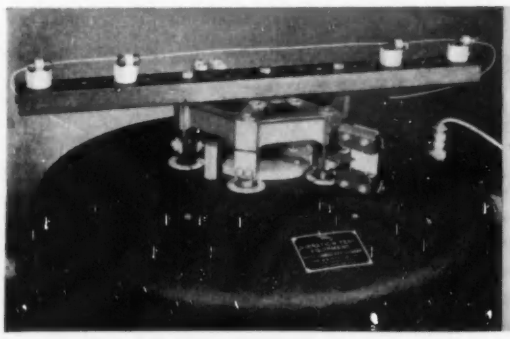
Vibration testing tells how well a product will bear up in service, reveals design faults, determines fatigue strength.

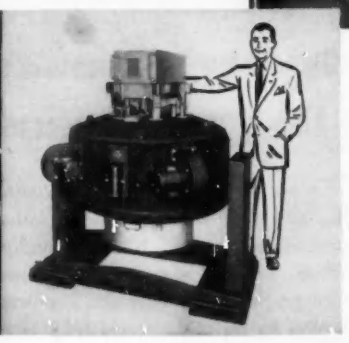
Designed for heavy duty service, MB vibration exciters such as the Model C-5, rated at 750 pounds force, and the Model C-25 rated at 3500 pounds force, deliver maximum performance, pure table motion and dependable operation.

Send for detailed specifications on MB cycling systems. Also for Bulletin which gives data on vibration exciters.



MB MODEL T-25 MC CONTROL CABINET with automatic cycling system developed to control the action of vibration exciters to a specified cycle of events, and with little or no supervision.





A VIBRATION TEST set up on the Model C-5 MB Vibration Exciter—and also one on Model C-25—two of the models which can be automatically controlled by MB's cycling systems.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-7.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT

The crankshaft in the modern V-8 engine requires the ultimate in forging technique. Today's high compression engines, with continually increasing horsepower, further emphasize the importance of forging quality.

Wyman-Gordon technical know-how assures quality essential for maximum physical properties, uniform machinability and balance control . . . crankshaft forging specialists since the introduction of the internal combustion engine.

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Detroit Vernatherm thermostats assure the accurate control of engine temperature necessary to maximum engine efficiency. These thermostats were pioneered by Detroit Controls Corporation to meet the requirements of modern pressurized cooling systems. Vernatherm engine thermostats will stay tightly closed against high pump pressures. Long, trouble-free service is provided by the specially developed temperature responsive compound used in Vernatherm thermostats to give powerful thermostat operation.

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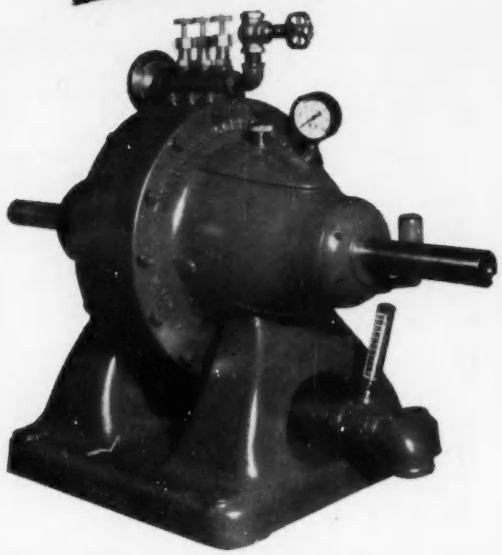

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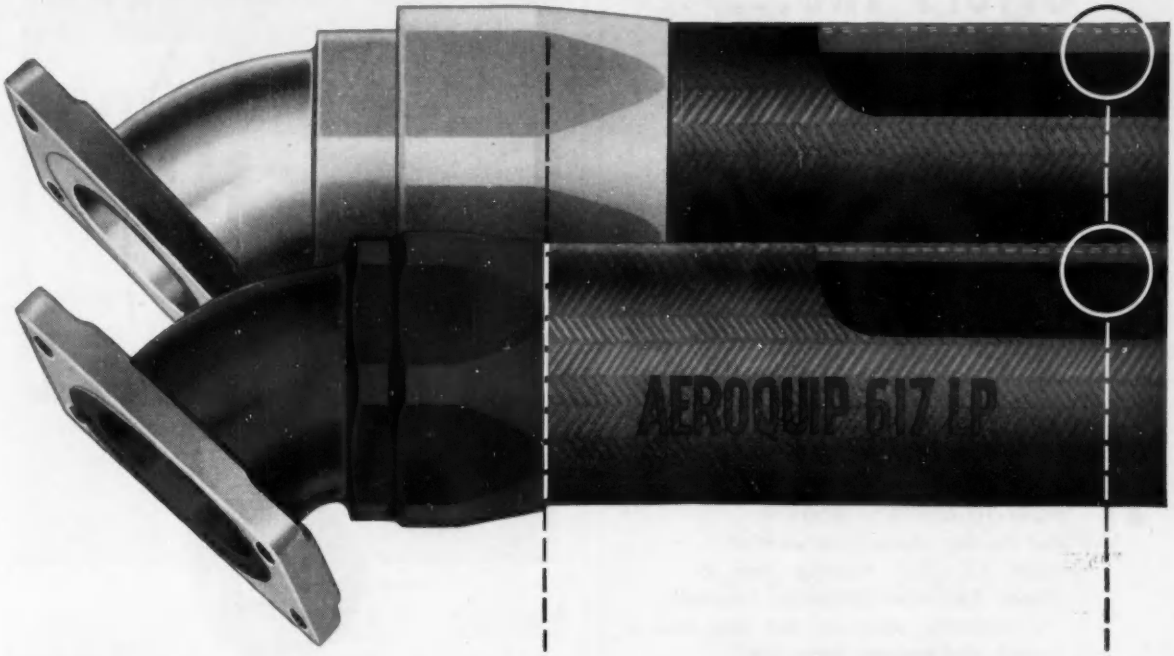
Save up to 150 lbs. per Plane!

with Aeroquip 617 Lightweight Air Frame Hose



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Thin wall construction and less wire braid hold weight to a minimum.

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617 hose and fittings are available from stock with AN756 flanges and standard AN818 swivel nuts in straight, 45° and 90° elbows. Sizes are —16, —20, —24, and —32.

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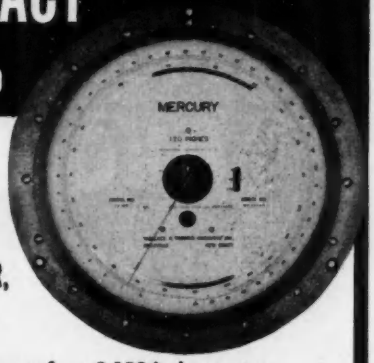

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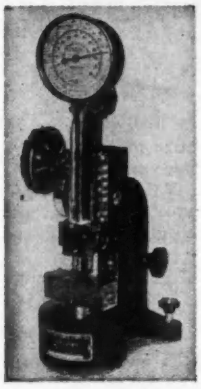

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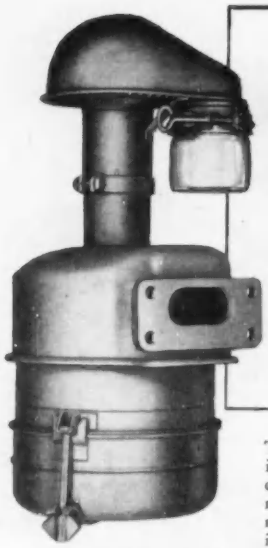

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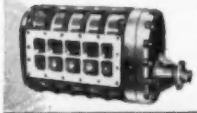

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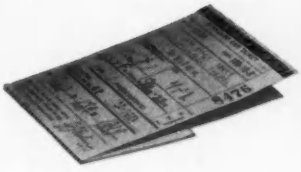

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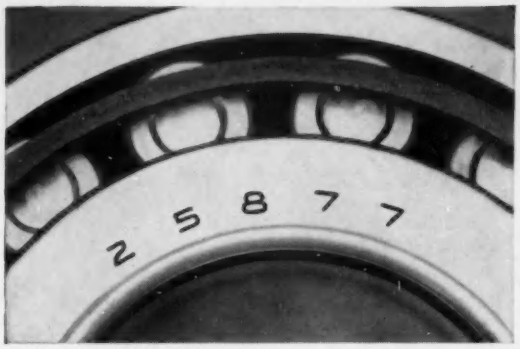

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